

RADIOLOGY

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NO 1

THE TREATMENT OF SELECTED CASES OF CHRONIC CATARRHAL DEAFNESS BY X-RAYS¹

By FREDERICK W. O'BRIEN, A.B., M.D., *Boston*

A REFERENCE to the treatment of catarrhal deafness and head noises by x-rays occurs as early as 1904 in a paper by Joseph Beck (1), of Chicago. The patient was a woman of 51 who, after four months of conservative treatment for what her physician diagnosed as a chronic catarrhal condition of the middle ear, was submitted to an ossiculectomy. Only partial relief of the ear noises followed. She was then given x-ray treatment to the ears for about three weeks without the slightest relief, whereupon radium was applied directly to the tympanic cavity every day for about six weeks with equally poor results. No mention was made of the x-ray factors.

In 1906 Dionisio (2) reported 20 cases treated by x-rays, the patients suffering from chronic suppurative inflammation of the middle ear. Sixteen of these cases were cured, he states. The hearing of many of them also improved.

From that time on many papers appeared in the literature describing the effect produced by x-rays or radium on impaired hearing and tinnitus. Desjardins (3) reviewed critically some fifty which appeared up to 1930 and concluded that irradiation may influence tinnitus especially and sometimes also exert a favorable action

on hearing. The crudity with which some of the treatments was often conducted must, he believed, undoubtedly account for a certain proportion of the failures.

The cases here recorded were all examined by a single otologist and the diagnoses made of chronic catarrhal or secretory deafness. No case of chronic suppurative middle ear disease or otosclerosis was treated knowingly. Each case was referred only after all the customary otological-therapeutic procedures had been practised without avail. Each patient had the commonly accepted hearing tests of whispered and spoken voice, tuning forks, and a modified Rinne before and after the x-ray treatment series.

The same x-ray formula was used in the entire series and the physical set-up was checked at frequent intervals to keep the radiation identical as far as could be.

From 1929 to 1935, inclusive, 140 patients were treated. Of this group, 73 were improved as to hearing and tinnitus, 65 were unchanged, and two were made worse. In the unchanged group are included 14 cases on which there was no adequate follow-up.

Of the improved group, 67 had nine treatments to each ear and six received only eight treatments. Since all of these patients showed improvement and only four cases of the total group who received less than nine treatments showed improve-

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ment, I have designated nine treatments as the acceptable course or cycle

There were 20 patients of the 51 followed and classified as unimproved who had nine treatments each. The remainder had as few as two treatments and none more than six.

There were 20 cases of the 140 who had tinnitus. Eighteen of these were in the improved group; the other two are the only ones of the entire series that had nine treatments who were reported by the otologist as having been made worse by x-radiation.

Accepting a cycle of nine treatments as the optimum, approximately 78 per cent who received it were benefited. No patient has been followed less than a year, the majority for more than three years, and some as long as five years.

The audiometer was not used because at the beginning of this work one was not available. It has rightly been said "The ability to hear the human voice is, after all, the most essential criterion of the hearing ability." A psychic element, I believe, can be ruled out as playing any major part in the improvement in a group as large as this that has been checked by a competent aurist and followed as long. A comparable rise in voice test from 1/20 W 1/20 to 20/20 W 20/20 from 1 ft V 1 ft to 20 ft V 30 ft, following x-ray therapy in a substantial group of cases should not be charged to accident or psyche.

There were six patients treated in the age group one to ten, 15 in the age group ten to twenty, 52 in the age group twenty to thirty, 33 in the age group thirty to forty, 21 in the age group forty to fifty, and 13 in the group over fifty years of age. The youngest was aged two and one-half, the oldest sixty-nine years, about equally divided among males and females.

The much abused tonsil did not seem to play a direct part in the beneficial outcome of x-radiation of these cases. Forty-eight of the improved group of 73 had had tonsillectomy from one to twelve years before x-irradiation. Of the 20 patients in the unimproved group who had the optimum cycle of x-ray treatments, 14 had had tonsillectomy.



Fig 1

The x-ray factors employed were as follows: 145 kv, 5 ma, 0.25 mm Cu and 1 mm Al filter, 50 cm distance, 15 X 15 cm field, 5 minutes' duration, about 90 r in air to each ear-field at one sitting and repeated at weekly intervals for nine treatments. A large field with the hypotenuse of the two right-angles extending from nares to mastoid tip (Fig 1) was chosen deliberately to include the nasopharynx, the course of the eustachian tube, the mastoid and ear structures, because of the accepted relationship of lymph adenoid tissue and infection to chronic catarrhal deafness and, at the same time, to include the origin and distribution of the eighth nerve and its communications in the temporal bone for possible neural stimulation.

How x-ray therapy brings about improvement in cases of chronic catarrhal deafness may always remain in the realm of controversy. As a matter of clinical experience, I do not think it is necessary to go to the extreme of discussing the improvement as seen in these cases, as did Stokes (4), on the basis of the electrical theory of matter. He believed that electronic equilibrium was the governing factor in metabolism and that deafness could be cured readily by electronizing the pituitary and auditory regions by small "ionizing doses" of roentgen rays. His dosage seemed infinitesimal. McCoy (5), who followed his method and reported a mixed group of

deafness cases, states "Whether there is penetration to the pituitary gland is a question, but that some change takes place in it is given food for thought by the alteration in blood pressure" This statement was based on two cases

Jarvis (6), in reporting his series of cases, seemed much more rational. He found that the type of patient subject to frequent head colds with more or less constant catarrhal discharge of the throat and frequent intervals of stuffiness in the ear, with an accompanying impairment of hearing, responded best to the use of roentgen rays. In these individuals he often found the inferior and middle turbinates increased in size, lymphoid nodules present on the posterior pharyngeal wall, and often a prominent band of lymphoid tissue running up either side of the pharynx just posterior to the tonsillar pillar. A study of the lymphoid tissue in the throat following the use of roentgen rays showed that in 48 hours it markedly decreased in size and redness and, with it, the catarrhal discharge from the throat. His dose was so small that he did not believe it could affect the lymphoid tissue but influenced, rather, the bacterial content of the throat.

Lymph adenoid structures are highly radiosensitive and the response of chronic inflammation to x-irradiation now seems well established. Bacteria which *in vitro* will stand enormous doses of radiation, lose their virulency *in vivo*. The softening effect of x-radiation on scar tissue following the operation for breast cancer, which enables the adhesions in the neighborhood of the axilla, the result of the operation, to become stretched, and on scar tissue following burns and keloid formation generally, is commonplace.

If deafness is due to fibrous tissue which may be comparatively small in amount, binding together the ossicles which transmit the vibration of the drums to the auditory apparatus, it is reasonable to believe that the x-rays may likewise affect the inflammatory exudate which gradually becomes adhesive in quality and attaches itself to the ossicles.

On the other hand, nerve tissue stands at the other extreme and is considered radioresistant. The beneficial effect of x-radiation on the sympathetic nervous system, however, has been affirmed repeatedly. The anesthetic effect of roentgen rays on nerve pain is a common experience. Improvement in both sensory and motor phenomena occurs in syringomyelia.

Richardson (7) believes that the neural stimulating dose, as he calls it, has a place in the treatment of deafness, and especially tinnitus. His dosage factors are 50 kv, 8 ma, 24 in distance, 1 mm Al filter, 12 seconds, distributed over the entire head through four portals of entrance. He states that it nearly always quickly relieved the tinnitus aurium, furthermore, he could not discover that the original pathology plays the obviously determining rôle with its effect on the efficiency of the treatment. Improvement in hearing, when it occurs, is either astonishingly immediate or is delayed for some time, becoming apparent only after several treatments, the gain is apparently a progressive series of steps. His records, based on 600 cases, show improvement from a slight degree to a complete cure, in not less than 60 per cent of a mixed group of cases. The fact that the auditory nerve differs from the optic and olfactory nerves in having a peripheral as well as a central origin, Richardson believes may have a bearing on the importance of the neural effect of radiation.

CONCLUSIONS

1. Seventy-three cases of chronic catarrhal deafness of a group of 140 of varying degrees of deafness were improved by roentgen-ray treatment.

2. Eighteen patients with tinnitus in a group of 20 were cured.

3. What is believed to be an optimum cycle based on certain definite x-ray factors is described.

4. Sixty-five cases were unchanged and two were made worse by x-irradiation.

5. No case of nerve deafness or otosclerosis was treated.

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PITUITARY AND ASSOCIATED HORMONE FACTORS IN CRANIAL GROWTH AND DIFFERENTIATION IN THE WHITE RAT A ROENTGENOLOGICAL STUDY¹

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IN man, in a large proportion of cases in which the cranial skiagram gives evidence of cranial dysplasia, there is found, clinically, evidence of past or present disturbance of pituitary function either during the growth period, subsequent to it, or throughout life. Such disturbance, whether it be on the side of hyperfunction, hypofunction, or a period of the former followed by a phase of the latter, we shall describe under the general heading "Pituitary Dysfunction." By cranial dysplasia we mean such abnormality in form or structure that the skull can be regarded as "malformed," the degree of this being subject to wide variation, ranging from a proportion and structure which cannot be regarded as outside the zone of supposedly normal variation, to gross deformity. Thus, the skull may be proportionate in its component parts and structure, the abnormality lying in its being too large or too small for the sex and age of the patient, the facial component may be disproportionate to the size of the brain-case through overgrowth or underdevelopment of either the former or latter, the component parts of the face, respiratory and masticatory, may be disproportionate one to the other, from overgrowth or underdevelopment of either. There may be such a calvarial contour as is abnormal for the sex or age or even for the stock to which the individual belongs. The brain-case may be abnormal in thickness or density, or its normal architectural structure, of three tables, may be lost to a lesser or greater degree.

Clinically, from such a correlation between cranial dysplasia and pituitary dysfunction, a causal relationship may be presumed between them, nevertheless, the

need is felt of experimental evidence to demonstrate the influence of pituitary hormones on cranial size, form, and structure. For this reason it was decided to examine roentgenologically the crania of rats treated with various relatively highly purified pituitary hormone-fractions.

Against the disadvantage of the fact that the rat cranium has not been the subject of any extensive study by cranologists may be set several distinct advantages, the rat of the Wistar stock is stable morphologically, it is in wide use for experimental purposes, its skull in many ways shows a pattern of growth not unlike the human, and there is a well marked difference to be seen in size and proportions between the male and female crania. But the chief advantage lies in the fact that the same animals, studied radiographically, have been investigated physiologically by a number of workers whose findings are available for confirmation or control of x-ray findings, especially is this true of animals that have been the object of calcium metabolism studies and in which the daily output of calcium, and the balance, is known over relatively long periods.

There are certain advantages in investigating this problem by a roentgenologic method, the chief being that observations and conclusions drawn from it are directly transferable to the clinical field of human radiology. In this latter, craniometry so far is in very slight use in the living patient, whereas cranial skiagraphy is almost a routine procedure and gives, in addition, important information not available to the craniometrist of the living patient, namely, a relatively accurate impression of the thickness of the skull and of its architectural structure.

There are, however, considerable roentgenologic difficulties to be overcome in studying the rat cranium. In size it is

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architectural structure and density of the bone at different sites. Although this can be achieved by radiographic and photographic processes being maintained constant, it is desirable in all cases that one should be able to check on such constancy. To permit of this there is placed upon the cassette, with the cranium, a penetrometer of 99.9 per cent pure cast aluminium, which measures 41.25 mm long by 3.55 mm wide. The 11 steps range from 0.5 mm in thickness, by increments of 0.5 mm, to 10 mm, except in the last three steps, in which instance the increment is 2 millimeters. The skiagram of this gives not only a measure of the absolute density, but shows whether or not two given skiagrams are comparable—an essential in comparing the skiagram of a treated animal with its control.

The Rat—This department colony was started in 1928 from 13 pairs of Wistar rats, and at the time this work was done it numbered about five thousand rats, about one thousand of which had been hypophysectomized. The females are used for breeding at about the tenth week of life, being discarded when they show low fertility or poor condition, the males are mated at about twelve weeks, and continue in use until about eighteen months old, when they usually begin to show such signs of age as harshness and yellowing of the coat. For general laboratory purposes a rat is considered "adult" when about three months old, although sexually the females mature, on the average, anywhere from the forty-fifth to the sixtieth day of life, and cases of maturity have occurred as early as the thirtieth day.

The average litter is about six pups, but 16 has been recorded and the lowest has been two. The young are allowed to suckle for the first month of life, although they begin to eat cage food as early as the twelfth day. The diet was originally a modified McCollum diet, later, "Purina" dog chow only has been given.

On the average 10 litters are born daily, giving a yearly birth roll of about 20,000 rats, which, with a constant population of

about 5,000, means a yearly consumption of 15,000 animals. A large part of this represents animals used about the twenty-first day in the assay of "maturity" (pituitary) hormone, A.P.L. and for the Aschheim-Zondek test. Ketogenic hormones are assayed on animals of about forty days of age, while for somatotrophic, thyrotrophic, and adrenotropic hormones rats slightly older or about 100 gm of weight (60–90 days) are used, such animals having been hypophysectomized about a month previously. For assay of the last three pituitary hormone-fractions, the hypophysectomized rat is routinely used.

We think it desirable to give the foregoing facts about the colony, since they have an important influence in the growth of the normal animal, and it enables other workers to compare our material with their own. The special needs of this laboratory are the reason why the rats, whose cranial skiagrams appear in the plates, are for the most part "young adult" animals, and there may appear to be a lack of what, elsewhere, may be regarded as, anatomically, fully grown adults. We have found, however, that our growth curve closely parallels those given by Donaldson (3) for the Wistar colony.

Radiographic Expression of the Morphological Changes in the Skull of the Albino Rat during Normal Growth—Of the 232 rats in which the cranial skiagram has been studied by the above technic, 44 were normal controls, 12 of them being females. They ranged in age from one to 13 months, and were selected by size and weight as representative of the average in the colony at various stages of growth. In the illustrations, only males are shown, since in the rat not only is the male skull larger (1), but also, as in man, as full adult growth is attained, it becomes more markedly differentiated. The nasal bones are longer, muscular attachments are more strongly developed, particularly the supra-orbital ridge and its posterior prolongation from which the temporalis muscle finds origin and which is homologous to the superior curved line of temporalis attachment in

small, even in a fully grown male at the age of one year the cranium measures in total length only about 43 mm, while its height is only about 11.5 mm (1). Thus in employing the technical equipment used in man it is very difficult to secure structural detail comparable to that seen in the human cranial skiagram. The question of placing the cranium for a true lateral view is also difficult.

Technic—In the preliminary study only dissected crania were used. The animal is killed, the lower jaw disarticulated, and all soft tissues removed from the snout and brain-case by immediate dissection. If this is begun in front, at the base of the upper incisor teeth, the soft tissues down to the periosteum can be swept upward and backward off the snout and vault, clearing the orbits and zygomatic fossæ simultaneously *en masse*, in the same way the hard palate and the base of the skull can be cleaned. The skull is then sawn longitudinally into two exact halves by means of a thin disc saw on the dental engine. This is first carried one saw thickness to the left of the suture between the nasal bones so that the septum remains intact on the right half-cranium, and, at the level of the frontonasal suture, it is made to cut the serrations of the suture between the two halves of the frontal bone. It travels backward along the sagittal suture, spreading the digitations so that there is no difficulty in keeping the exact midline, the cut ends at the foramen magnum. On the palatal aspect the saw enters between the incisor teeth and divides the hard palate, one saw breadth to the left of the middle line. At the posterior nares it enters the body of the pre-sphenoid exactly in the middle line, divides the ethmoid, pre-sphenoid, basisphenoid and basi-occipital bones to the foramen magnum. The brain is removed and the two halves of the skull dehydrated in alcohol for 12 hours and allowed to dry. The two halves of the mandible are separated, cleaned, and similarly treated. Both halves of the cranium and jaw are skia-graphed.

It was found that the modern fast,

double-emulsion x-ray film was quite unsuitable for the radiography of the dissected cranium, the grain is relatively coarse and the effect of this is increased by the double emulsion. These facts cause considerable lack of detail-definition in the subsequent enlargement, for these skiagrams can be studied adequately only when enlarged about three to five times. It was ultimately found² that a fine grain emulsion, such as is used in miniature cameras, Du Pont "Micropan" or Eastman "Panatomic" negative film, gave excellent results.

This is loaded in thin light-opaque paper cassettes, low kilovoltage (below 40 kv), 15 ma, with an exposure of about eight seconds became a standard technic. The anode-film distance was 15 inches and a Westinghouse line-focus³ tube was used. Development was five minutes in Eastman x-ray developer (D-19-B), all processing solutions being held at 18° C by a thermostat operated by a Black (2) relay. This technic gives an x-ray film of excellent contrast, freedom from grain and fine detail, from which a copy-negative is made on fine-grain film, using a Leica camera critically focussed by means of a sliding focusing copy attachment. The camera is at a constant distance from the illuminator so that the relative sizes of crania are preserved. Exposure is constant and development is for 10 minutes, in fine grain developer (Eastman D-76), at 18° C. Enlargement is on paper or "Translite" film, film-paper distance is constant as are both exposure and development, which are measured in seconds by metronome. Thus, throughout the whole standard process, as nearly as can be achieved, the only variable that occurs is that of density of the individual cranium.

The Penetrometer—In the skiagram it is essential to get an accurate impression, not only of cranial size and relative proportion of snout to brain-case, but also of

¹ We wish to acknowledge our indebtedness to Mr W S Trotman of the Eastman Kodak Co. of Canada for his help in experimenting with a large series of emulsions.

² Supplied by the generosity of the Westinghouse X-ray Company Inc. New York City.

and upwardly inclined plane of the interparietal bone. It consists of two light tables of bone separated by numerous trabeculae, the diploic table being thick and richly vascular. Anteriorly, this table is abruptly pinched off at the interparietal-parietal suture. This point marks the line of attachment of the tentorium cerebelli on the inner surface.

Forward of this the calvaria is seen to be composed, as it were, of three arches (No 16, Fig 1). The first is formed by the parietal bone and its anterior end indicates the site of the parieto-frontal suture. If skiagrams No 16 and No 86, in Figure 1, are examined with a loupe, it will be seen that the inner table is denser, more compact than the outer, and that the middle table in this bone is less well developed than elsewhere in the calvaria, so that the parietal bone, at the top of the arch, presents in the skiagram the appearance of the outer table being almost directly applied to the inner. In the fresh state, the bone when looked at from above shows no vessels and is almost translucent. In the rat this segment is the thinnest part of the calvaria, just as in man the calvaria is thinnest at the parietal eminence.

The middle and anterior "arches" in the calvarial outline are formed by the frontal bone, the posterior end of the middle arch being the frontoparietal suture, while the anterior end of the anterior arch is at the frontonasal suture. At the junction of these two arches is the posterior of two diploic expansions whose presence in the frontal bone make it the most richly vascularized component of the calvaria. The area of bone in which these two expansions lie is comparable to that in which is developed the frontal sinus in man, the region of the frontal bone adjacent to the frontonasal suture and the supra-orbital ridge. When a freshly dissected rat cranium is viewed from above (Fig 2) it is seen that the frontal bone has three vascular areas separated by two relatively avascular parts. The most posterior is adjacent to the frontoparietal suture, the anterior to the frontonasal suture, while the middle is



Fig 2-A Vascular anatomy of the rat calvaria. *Bones* I P, Interparietal, P, parietal, F, frontal, N, nasal. *Sutures* A, interparietal-parietal, B, fronto-parietal, C, interparietal, D, interfrontal, E, frontonasal. *Vessels* 1 2 4, para sutural diploic vessels, 3, orbito-frontal diploic vessels "C," "Supra ciliary" canal, "R," temporal crest.

directed from the midline outward and somewhat forward, by means of a foramen there is communication between the vessels of the frontal bone diploe and those of the orbital cavity. This is the largest vascular foramen to be seen on the exterior of the rat cranium, it lies under cover of the supra-orbital ridge, about the midpoint of the orbital cavity. It is found in the great majority of young animals, but there is a tendency for it to be obliterated, especially in male animals, in which development of the supra-orbital ridge is increasingly marked with advancing age. It is to be considered as a homologue of the supra-ciliary canal in man of which anatomists as a rule do not give extensive description. LeDouble (4), however, states

"One minute orifice, situated at the base of the incisura, or of the supra-orbital foramen, is the origin of a canaliculus whose course depends on the size of the frontal sinuses. When these do not extend vertically above the ophryon and, laterally, more than 1.5 cm from the median line, the canaliculus arises vertically and, after a very sinuous course, loses itself in the diploe, which separates the

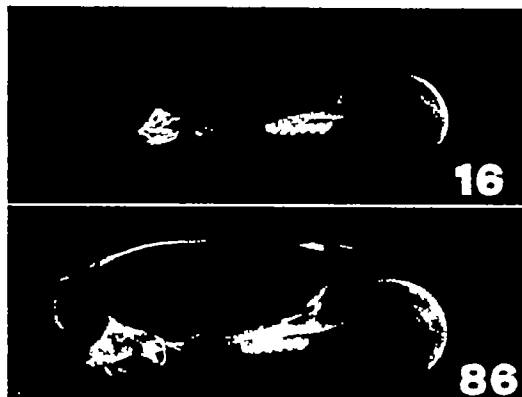


Fig 1 Normal controls No 16 age 31 days, weight 50 gm male No 86 age 46 days, weight 128 gm male

man, but the chief difference is found in the greater development of the supra-orbital bar which increases the acuteness of the fronto-nasal angle and the more marked development of the frontal sinus homologue behind it

Comparative Anatomy of the Rat Cranium as Seen in the Skiagram—Posterior-inferiorly (No 16 and No 86, Fig 1) is seen the tympanic bulla, the three semicircular canals and between those the denser petrous portion of the temporal bone in which can be distinguished the bony canal of the cochlea. Superimposed upon the shadow of the tympanic bulla anteriorly can be seen the synchondrosis between the basi-occipital and the basi-sphenoid bones, which forms the landmark in drilling the basi-sphenoid in the operation of hypophysectomy by Selye's (6) modification of Smith's method, the trephine being placed just anterior to it. There is no sella turcica in the rat, the pituitary gland lying upon the basi-sphenoid about the level where the shadow of the tympanic bulla cuts this bone. More anteriorly is seen the synchondrosis between the basi-sphenoid and pre-sphenoid, at the anterior end of which bone is seen the shadow of the optic foramen. Vertically above the middle of the pre-sphenoid is the broad attachment of the posterior root of the zygoma from which this bone sweeps forward and downward.

In front and above the optic foramen is seen the cribriform plate of the ethmoid

and the inverted U-shaped shadow of the anterior root of the zygoma. Below the former is the alveolar process of the maxilla bearing the three molar teeth, the roots and pulp cavities of which show clearly. The first molar erupts about the nineteenth day, the second about the twenty-first day, while the third erupts about the thirty-fifth day. In No 16 it is apparent that the third molar is not quite completely formed and is only partially erupted. As Donaldson (3, p 52) points out, "Owing to the lack of precise data, no exact comparison can be made with the eruption of the corresponding teeth in man. Nevertheless, the incisors and first and second molars in the deciduous dentition of man do erupt at about the equivalent ages (i.e., thirty times the age in the rat) while the relation of the age of eruption of the third molar (the 'wisdom tooth') to that of the second molar is similar in the rat to that found for these teeth in the permanent dentition of man." A wide diastema separates the molars from the incisor teeth, which erupt from eight to ten days after birth, are rootless, and grow throughout life at the average rate of 2.2 mm per week in the upper, and 2.8 mm in the lower incisors (Donaldson). The upper incisors are strongly curved and form a large segment of a circle. The anterior surface of the tooth is both thicker and denser in the skiagram than the posterior, due to its being composed of dentin and enamel, while the posterior is dentin and cementum. The tooth is largely hollow and the gradual tapering of its wall to a fine point at the proximal end of the tooth or "root" is characteristic of the normal.

Posterior to the shadow of the semicircular canals is that of the occipital condyle, which is lateral to the foramen magnum. Superior to this is the supra-occipital bone which forms an angle with the interparietal bone.

The calvaria is of much importance in this study and the characteristics of its components can be recognized already at the first month (No 16, Fig 1). From behind forward, the cranial vault is composed of three bones. First is seen the forward

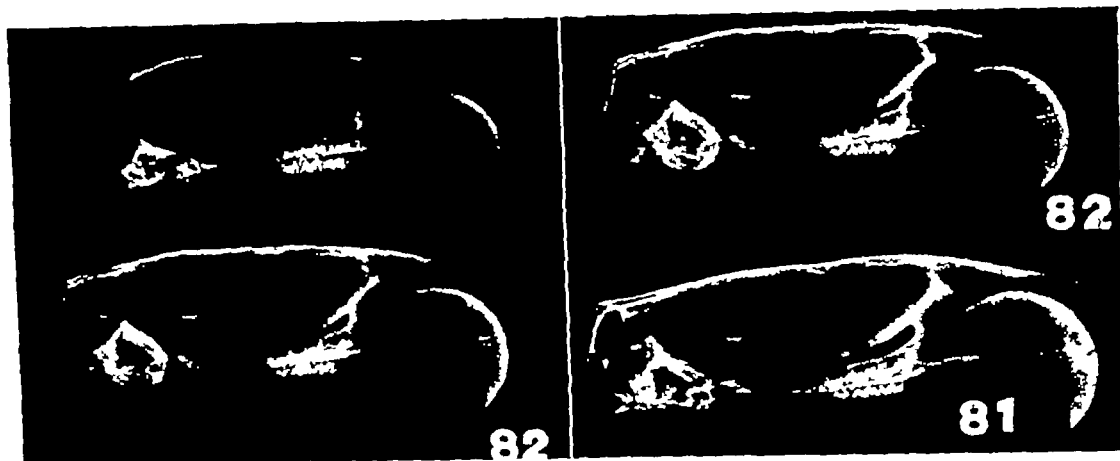


Fig 3

Fig 4

Fig 3 Normal controls No 86, age 46 days, weight, 128 gm, male No 82, age 97 days, weight, 193 gm, male
 Fig 4 Normal controls No 82, age 97 days weight 193 gm, male No 81 age 170 days, weight, 266 gm, male

throughout, at this age, is very poorly calcified, as are the teeth, and there is no great difference in density between inner and outer tables of the skull

By the sixth week (No 86, Figs 1 and 3), a marked change has taken place. There has been a rapid increase in size, not only in the brain-case, but to a relatively even greater extent in the snout, both antero-posteriorly and vertically, the height of the skull above the molar teeth has markedly increased. Thus, the outline of the calvaria is considerably straightened out and this has been contributed to by the pull of the nuchal muscles on the occipital-interparietal angle, associated with increasing use of the jaw, also, the teeth are larger and better calcified. There has been a well marked increase in density of the calvarial inner table, and a marked increase in size of the frontal sinus homologue. That the skull has also flattened in the transverse direction can be seen by the rise, toward the vertex, of the line of density which runs downward and backward from the region of the frontal sinus homologue, and which is caused by the increase in growth of the temporal crest. This is better seen in comparing Fig 3, No 86, with No 82, where the temporal line has risen to a position just below the calvarial shadow. At this age, three months, the

facial part of the skull has still further gained upon the brain-case in vertical height. The incisor tooth is very much larger and better calcified, the vault of the skull, except in the parietal region, where a little dome-effect remains, is practically straightened out, and there is seen the beginning of angulation at the frontonasal angle, with a simultaneous increasing density at the root of the nose and a progressive enlargement of the anterior component of the frontal sinus homologue.

These changes are seen to have progressively increased by the sixth month, at which date (No 81, Fig 4) the greatest vertical height is seen over the molar teeth. The angulation in the frontonasal region is more marked, the bone is denser, and the frontal sinus homologue proportionately larger, while by the end of the first year of life (No 12, Fig 5) it becomes evident that the chief differentiation change in the rat's cranium is related to mastication. The snout is at least half the mass of the total skull, and there has been built, to meet this physical need, a dense supra-orbital bar. The point of junction of the relatively light brain-case with the powerful snout has been strengthened, not only by the mechanical means of angulation at the point of maximum strain, but by the reinforcement of this area by an increased den-

two tables of the anterior aspect of the bone. When the frontal sinuses are very extensive, it penetrates horizontally into the roof of the

canal'. Of 105 adult skulls, I found it present in 72. He found it constantly present in the fetal skull.



"Supra-ciliary" Canal.

Fig 2-B



Fig 2-C The frontal-sinus homologue

orbit, on the endocranial table of which it runs as far as the neighborhood of the orbital foramen, where it bends to course along the anterior wall of the sinus in which it opens at a variable height, unless it opens on the external aspect of the frontal bone."

In 614 arches (307 skulls) d'Este found this canaliculus missing in only 26. It includes a small nervous filament arising from one of the end branches of the supra-orbital nerve and which is called in Germany "the nerve of Kobelt."

According to Ward (5), "this notch constantly presents the orifice of the canal which transmits nutrient vessels upward into the substance of the frontal bone. It is often of considerable size, sometimes double. It generally remains pervious in adults and may be called the 'supra-ciliary

In the deer, where there is no frontal sinus, this area of the frontal bone forms the boss of the horn, and here the foramen is multiple and large in size, the same is true in the ox, where the frontal sinus is extremely extensive. In the rat, as the skiagram of the normal animal's growth is followed in this area, its functional significance will become apparent.

We regard, therefore, these two expansions of diploe as homologous to the human frontal sinus, although they have no communication with the nose and contain only a rich vascular marrow (Fig 2-C).

This vascular arrangement in the frontal bone in the rat makes possible the marked changes which take place in this region in growth, changes which depend on the great functional activity of the maxillæ and mandible.

At the end of the first month of life the cranial skiagram shows (No 16, Fig 1) a typically infantile condition. As in man in infancy, the brain-case is relatively large and the snout (face) small. The greatest vertical height is behind, vertically above the spheno-occipital synchondrosis. The calvaria is curved, not only anteroposteriorly but also transversely. The bone

they continue to gain until the weight is about double that at the time of operation. This estimate of "growth" is based upon gain in weight, the nature of the growth, which characteristically follows hypophysectomy, becomes evident from study of the skiagram and measurement of the skull.

The skiagrams in Figure 6, Nos 895-A and B, are enlarged one and one-half times, B, the control animal, is normal in size for a female in the eighth month of life. The magnification in Figure 1 is the same and, if 895-A is measured from the supra-occipital-interparietal suture to the tip of the nasal bone shadow, it will be found to be considerably shorter in this dimension than its control. But, on the other hand, it is considerably longer than No 16 (Fig 1), the length of which is normal for a rat of 31 days, although 895-A was hypophysectomized on the twentieth day of life when, it is to be presumed, its cranial length was less than No 16 measures. The cranial length of 895-A is equal to that of No 86, which is 46 days old. If a curve is constructed from the figures given by Donaldson for naso-occipital length, from the twenty-third day to the tenth month, the values being multiplied by 2.5, it becomes evident that the control animal at 223 days of age has a total cranial length in agreement with Hatai's figures, whereas, the hypophysectomized animal's naso-occipital length would have, on such a curve, a value corresponding to an animal

of 64 days of age. The skull of the animal, hypophysectomized on the twentieth day of life, has very evidently grown in length.

Compared with the control 895-B, measured on the skiagram, it shows a retardation in cranial length of 14 per cent. Also on the skiagram, the cranial height, taken above the occipito-sphenoid synchondrosis, is the same in both animals, but, anteriorly, measured vertically above the first molar tooth, there is retardation in the animal operated upon, of 16 per cent. The most striking fact that becomes evident, however, is that, while the hypophysectomized animal's skull has grown it has retained the early infantile proportion of snout to brain-case. If one compares it with Nos 16 and 86, its outline resembles much more closely the former than the latter. It is clear that the brain-case has suffered less than the facial part of the cranium or, in other words, that there has been a more marked failure in differentiation than in growth. From our study of the normal rat crania we have seen that differentiation in growth chiefly subtends the function of mastication, thus, when differentiation is chiefly affected its immediate reflection appears in the masticatory apparatus.

Measurement of the actual crania confirms these observations and demonstrates the singular nature of the change. In Table I, Hatai's maximum, mean, and minimum cranial dimensions are given for

TABLE I—CRANIAL DIMENSIONS OF HYPOPHYSECTOMIZED AND CONTROL FEMALE RATS COMPARED WITH HATAI'S MEASUREMENTS FOR NORMAL FEMALES

	Maximum	Mean	Minimum	895 B	895 A	Retardation Percentage
1 Total cranial length	44.5	41.5	38.9	43.5	36.5	16.1
2 Fronto-occipital length	28.2	26.4	24.9	26.5	23.5	11.4
3 Nasal bone	17.8	15.7	14.4	17.0	13.0	24.0
4 Cranial height	12.2	11.1	10.3	11.0	11.0	nil
5 Cranial width	16.2	15.1	14.4	15.25	15.0	nil
6 Upper incisor (extra alveolar at 8 months)		9.0		8.0	6.0	25.0
7 Lower incisor (at 8 months)		12.0		12.0	8.0	34.0
8 Upper diastema (at 8 months)		12.5		12.5	10.0	20.0
9 Lower diastema (at 8 months)		7.0		7.0	4.0	43.0
1 End of occipital to tip of nasal bone						
2 End of occipital to frontonasal suture						
3 Frontonasal suture to tip of nasal bone						
4 Perpendicular height above occipito-sphenoid synchondrosis						
5 Width at posterior zygomatic roots						

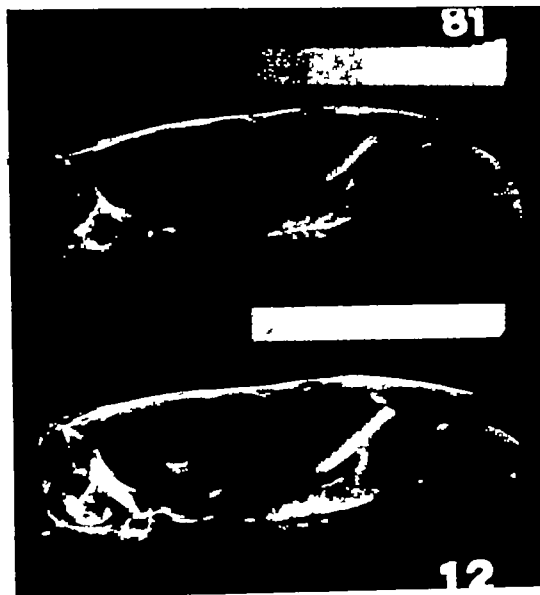


Fig 5

Fig 5 Normal controls, males No 81, age, 170 days, weight 266 gm No 12 age, 392 days, weight, 376 gm



Fig 6

Fig 6 The effect of hypophysectomy on the rat cranium No 895-A Female hypophysectomized on the twentieth day of life Age 223 days, weight 67 gm No 895-B Female day mate control, weight, 192 gm

sity of the bone, and, while this has been laid down, the subjacent area has progressively increased in size as a marrow cavity. It is obvious that there has been at work the same basic mechanism of growth as is seen in the shaft of a long bone, as it progressively increases in diameter in growth, namely, subperiosteal deposition of bone and central resorption in the medullary cavity. Thus, the snout of the rat is modelled to suit its mechanical function, and comes to resemble in outline the design of a jaw of a mechanic's pliers.

The Effects of Hypophysectomy on Growth and Differentiation—The crania of 40 hypophysectomized rats have been skia-graphed, and, as already stated, the hypophysectomized animals used for hormone-assay are operated upon when about from 50 to 70 days old. The extent of the resultant deformity of the cranium depends upon the age at which the operation is done, being more marked the earlier it is performed, and the longer thereafter the animal is allowed to survive.

No 895-A, Figure 6, is a female rat hy-

pophysectomized on the twentieth day of life, and allowed to survive till seven and a half months old. No 895-B, Figure 6, is also a female born of the same stock on the same day, weighing the same as the previous animal did on the day of operation, and living alone with it in the same cage, being sacrificed on the same day. Ten days after operation it weighed 36 gm, and on the day of death 67 gm, so that at death it had almost doubled its minimum post-operative weight. The control was almost three times heavier in body weight, its thyroid gland was almost three times heavier, its adrenals seven times, and its ovaries twelve times heavier. The operation was complete and the profound influence of pituitary lack on growth in general and particularly on other endocrine structures is obvious.

When a young adult rat is hypophysectomized, one about 100 gm in weight, growth immediately ceases. It has, however, been shown (7 and 8) that if very young animals are used (weight from 25 to 35 gm), growth does not stop, but that

less in its vertical measurement, while its outer table, instead of forming the convexity of the frontonasal angle, is depressed and somewhat concave, and its contained marrow aplastic

A similar condition is present in the basal bones of the skull which are considerably less "expanded" than normal, and in length are 20 per cent shorter than in the control. The ethmoid and its cribriform plate, as well as the zygoma, are considerably smaller.

Marked changes occur in the teeth after hypophysectomy (10 and 11). These are particularly well seen in the incisor tooth, which shows characteristic changes. The tooth is considerably smaller than in the control, being approximately two-thirds normal in size. It has lost its almost semi-circular form, and presents the appearance of the chord of the arc which it forms being considerably shortened. The gradual tapering of the walls of the tooth, as it is followed backward toward its base or "root," which characterizes the normal tooth, disappears. The pulp cavity is largely obliterated, so that, instead of the tooth being for the most part a hollow cylinder, it becomes largely a solid cylinder. The "root" is markedly abnormal in structure, thickened, and its outline irregular and notched, showing excrescences at the base.

During the seven months of post-operative survival in this animal, not only has the body weight almost doubled, and the skull grown, normally in certain directions and abnormally in others, but there has occurred a definite increase in density of the cranium. In comparison with No. 16, which it resembles in outline, and No. 86, which it approximates in length, it is apparent that its density is considerably greater than in either, even though it is much less dense than its own control, No. 895-B. It appears that calcium has been added in a measure which, while not adequate for its age, is still excessive both for its size and stage in differentiation. This may be looked upon as a process of relative sclerosis. The increasing acquisition of calcium may be considered as resulting

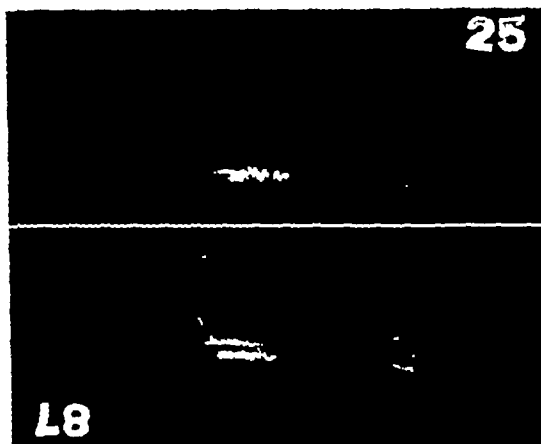


Fig. 7 The early effect of hypophysectomy. No. 25 Male, hypophysectomized on the eighteenth day of life, weight 35 gm. Skiagram on the thirty-sixth day, weight was then 44 gm. No. 87 Male control, age, 38 days, weight, 90 gm.

from that small increment in constituent elements which the cell acquires in virtue of what may be regarded as its integral growth potential, as the proceeds of its daily metabolism which still takes place, in the absence of the anterior lobe of the pituitary, although with lessened vigor, despite the fact that neither resorption nor expansion keeps pace. Thus, calcium is slowly added to a structure in which resorption lags and in which "expansion" is consequently greatly retarded.

Summarizing the effects of hypophysectomy on the growth and differentiation of the young rat cranium:

(1) There occurs a marked decrease in vascularity of the bone throughout the cranium, affecting the individual bones in the order of richness of their normal vascular supply.

(2) As a result, the processes of *pari passu* resorption and deposition, normally concerned in bone growth, are seriously impeded, but it would appear that the former is more affected than the latter.

(3) All growth does not cease, but as a result of the daily tissue metabolism, which, however, is undoubtedly depressed, there is for a time, during the normal growth period, a slow increment of the constituent elements, possible in virtue of the "integral growth potential" acquired by

normal adult female rats together with Nos 895-A and B. It is apparent that the control animal's measurements rank somewhat above the mean. Comparing the measurements of the hypophysectomized and the control, it appears that the greatest disturbance of growth in the hypophysectomized animal's cranium is in the anteroposterior direction, both cranial height and width showing no failure in growth. Occipito-nasal length is 16.1 per cent less and fronto-occipital length is 11.4 per cent less than the control, but the chief defect is in the nasal bones, which are almost a quarter less long than normal. The extra-alveolar length of the upper incisor tooth is affected to a similar degree, while that of the lower incisor is considerably more affected. The upper maxilla is 20 per cent less than in the normal animal, as indicated by the length of the diastema. Even more marked is the resultant defect on the lower incisor and mandible, as shown by a 34 per cent retardation in the lower incisor and a 43 per cent in the body of the jaw. This last fact may possibly be accounted for by the view that in growth the upper jaw acts as the "pacemaker" for the mandible.

Collip (8) is of the opinion that growth in the absence of pituitary tissue in very immature animals "shows that in early stages of ontogenetic development the organism must have an extra-hypophyseal source of growth-stimulating substances," and he cites "growth in length in reptiles and amphibia, which is largely independent of the pituitary," as a phylogenetic precedent for the ontogenetic growth that takes place in the hypophysectomized immature animal. But this cannot be regarded as an explanation as to why, after hypophysectomy, growth more clearly fails in the face than in the brain-case, nor why in the brain-case itself growth in the anteroposterior direction should be retarded, while, in the vertical and transverse directions it would appear to be unaffected. A possible explanation suggests itself in that growth of the brain-case as a whole is undoubtedly dependent upon growth of the brain, in the hypophysectomized animal

the brain is not so large as in the control and can be accommodated adequately in a brain-case which is 11.4 per cent shorter than normal, and whose height and width are normal. Growth in the forward direction would appear to be largely dependent upon or at least associated with forward growth of the face. The view is generally held that an important factor in facial growth lies in the masticatory effort and particularly is this true in the case of the lower jaw, in which the adequacy of dental occlusion also plays a part. In the hypophysectomized rat the muscles are poorly developed, of poor tone, and readily fatigued, appetite also is less. These facts must be taken into account in estimating the cause of the facial hypoplasia, but it is also evident that the absence of the anterior lobe of the pituitary imposes a handicap on growing bone in general which tends, peculiarly and particularly, to affect the growing snout, owing to the cancellous type of bone of which it is largely composed, the brain-case being structurally of more compact bone, which, while undoubtedly affected by hypophysectomy, is so to a less degree.

The skiagrams of the calvaria of these two animals show marked hypoplasia in its cancellous element—the middle table. This is very clear in the interparietal bone, especially posteriorly, where the three tables can no longer be distinguished, but it reaches its maximum in the parietal bone where the skiagram presents the effect of only one table being present. This does not mean that there is, histologically, complete obliteration of the middle table in this area, but that trabecular deterioration and marrow aplasia are present to an extent where the three tables appear as one in the skiagram.

The frontal bone is similarly affected in the areas between the vascular expansions, which suffer to a marked degree. This is particularly true in the anterior expansion which occupies the site more closely homologous to the human frontal sinus. It is not only much shorter anteroposteriorly (two-thirds the length), but is also much

mal animal as a rule approximately trebles its weight (12)

When compared with a standard control of the same stock and approximately the same age (two days older), there is no significant difference in the two animals in either cranial height or width, but, in the hypophysectomized animal, the total cranial length is 10 per cent less, the fronto-occipital length 5 per cent less, while already the greater impediment to growth is reflected in the nasal bones, which are 21 per cent less in length than those in the control animal. The skiagram shows, at this short interval after operation, changes typical of hypophysectomy, the calvarial contour is of an earlier infantile type, the middle table cannot be distinguished posteriorly in the interparietal bone, and in the anterior part trabeculae are not seen. Diploe is not apparent at all in the parietal bone (Fig 8), while in the frontal the diploic expansions are smaller, especially the anterior one, at the root of the nose, which, antero-posteriorly, is markedly shorter. The difference in length of the nasal bones is striking. The bones of the cranial base are very much smaller, while those at the interparietal-occipital angle are markedly less differentiated, possibly indicating retardation of development of the nuchal muscles.

Already in the incisor tooth can be recognized the beginning of those changes of which full development is so clearly seen in No 895-A. The tooth is smaller, there is angulation of its anterior wall at the junction of the proximal and middle thirds, at which site the wall is already thickened and definitely increased in density, while, toward the anterior end, the pulp cavity is less clearly defined, indicating its commencing obliteration. Eighteen days after operation it is clearly apparent that this animal has been hypophysectomized.

The general changes in the skeletal system, following hypophysectomy, are chiefly an osteoporosis simplex with disorganization of the trabecular structure of the bone and marrow aplasia, well seen in the lower end of the femur of a hypophysectomized rat. A similar condition may follow

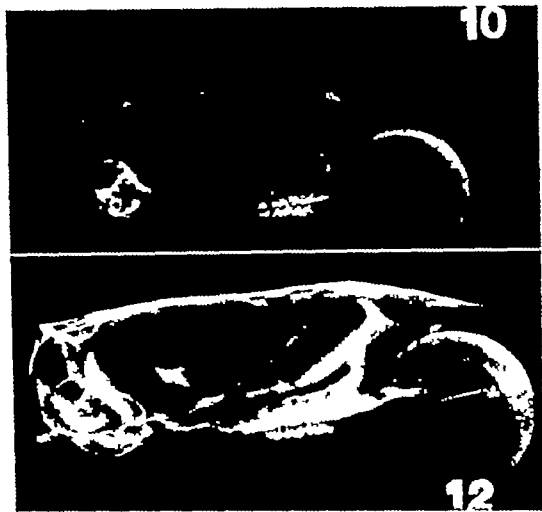


Fig 9 The effect of low calcium diet on cranial differentiation and growth. No 10, male, age 335 days, weight 162 gm. No 12, male, age 302 days, weight 376 gm.

such general states as starvation, avitaminosis or unhygienic surroundings, and consequently it has not been regarded as a change specifically following hypophysectomy. However, it is clear that the changes in the young cranium following hypophysectomy, as above described, constitute as a whole a syndrome specific for hypophysectomy in early youth. The general conditions mentioned undoubtedly can affect the structure of the bones of the skull and of the teeth, as well as the relative proportions of the cranium, but the general picture resulting in such cases will not easily be confused with that occurring in an animal that has been hypophysectomized in early life, and whose diet, vitamin intake, and surroundings have been satisfactory.

This is demonstrated in No 10, which is the skiagram of a rat almost one year old, that, since birth, has been on a diet containing only about one-tenth of the calcium content of the routine diet, and which is otherwise adequate. Both its parents had been similarly treated for some time previous to its conception, and the mother also throughout gestation. That there has resulted a marked inhibition of growth is apparent in the fact that its weight is less than 50 per cent of that of a normal animal.

the tissue in phylogeny, and there results a dimensional increase which, however, is not equal in all directions. It would seem

eruption and growth, their outline is deformed, and their pulp cavities are largely obliterated.

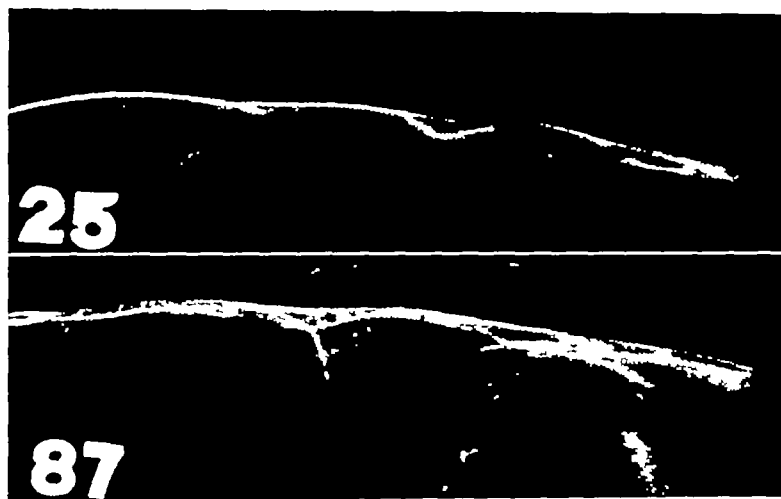


Fig 8 The frontal sinus homologues of No 25 and No 87, magnified about 12 times. Note the disappearance of diploe from the frontal and parietal bones in No 25.

as if a more adequate response results "passively" to growth in other tissues, such as the brain, than occurs in areas where full development apparently depends upon an "active" functional use of the areas, as a contribution to full differentiation.

(4) Thus, the brain-case grows more adequately in its transverse and vertical directions, inadequately in its anteroposterior.

(5) The snout, or facial part of the cranium, suffers relatively more than the brain-case, growth is inadequate in all directions, which may be due to the fact of its being largely composed of richly vascular cancellous bone which is profoundly influenced by hypophysectomy. Thus, there results the retention of an infantile proportion of face to brain-case.

(6) The calvarial diploe is hypoplastic and in the skiagram this appears earliest and most readily where the table is normally thinnest, *i e*, in the parietal region.

(7) There is marked hypoplasia of the frontal sinus homologue (Fig 8).

(8) The teeth are markedly retarded in

How soon after operation in a young animal the foregoing changes, characteristic of hypophysectomy, can be recognized in the cranial skiagram is a question of considerable interest. Since cranial growth and development is rapid in the first weeks of life, especially in the snout, in association with eruption of the teeth and the beginning of mastication of solid food, the changes following on hypophysectomy are more clearly apparent the earlier in life the operation is done. Unfortunately, however, in very young animals the difficulty of the operation is not only greatly increased technically, owing to the very small size of the field, but the mortality rate in animals operated upon prior to weaning is considerably higher.

Rat No 25 (Fig 7) was hypophysectomized on the eighteenth day of life by Dr Selye, the youngest age at which the operation has been successfully performed in the rat. It was sacrificed after an interval of 18 days, during which time it had added 25 per cent to its weight at the time of operation. At this period in life the nor-

about its own age. There is growth failure reflected, not only in total cranial length, but also, quite markedly, in the length of the nasal bones. Full differentiation has not taken place and a well marked fronto-nasal angle is absent, although there had been a fair growth in facial height above the maxilla. So poor is calcification that the calvarial tables show merely as fine lines. There is, however, no obliteration of diploe in the skiagram, on the contrary, the appearance suggests an increase in this table, but this is only apparent and results from such a profound decalcification of both inner and outer tables that the middle table appears relatively increased in thickness. Although there is an osteoporosis simplex present to a marked degree, the calvarial architectural structure is the reverse of that found after hypophysectomy. The incisor tooth, although markedly smaller than the control, is normal in outline, being almost semicircular. While the anterior wall of the tooth is considerably thicker than normal, resulting in a narrowing of the pulp cavity, there is no angulation in it and both walls of the tooth are normal at the proximal end, as they taper off to the "root." The dentin is of poor quality and there has been a fracture at the tip of the tooth. It is true that there has been a diminution in size of the pulp cavity, but the condition in no way resembles that which is found after hypophysectomy. This cranium could never be mistaken for that of a hypophysectomized animal.

The Effect of Hypophysectomy on the Cranium of the Dog—No 927 (Fig 10), a puppy of unknown, but certainly very mixed stock, the dominant strain being apparently fox terrier, was hypophysectomized by Dr. Carl Bachman at about the fifth week of life. Its litter-mates varied so greatly in size, markings, etc., that none could be justifiably used as a control. It is clear, however, that after a year's sur-

vival the cranial defects seen are, in the main, of the order of those found in the rat after hypophysectomy. The body length from the tip of the nose to the root of the tail had increased only about 9 per cent. It retained throughout its puppy characteristics and the cranium is largely that of a puppy. The snout has suffered severely, and there is crowding of the teeth due to hypoplasia of the jaws, particularly in the pre-maxillary region, where there is incarceration of the milk teeth and failure of eruption of some of the permanent teeth. The pulp cavities are reduced, especially toward the points, there is a marked degree of malocclusion and a very overshoot mandible. This is not due to overgrowth of the latter, but from failure in forward growth of the upper jaw—a good example of "progeniacism."

The calvarial outline has retained the highly convex contour of early puppyhood, the diploe is minimal in amount throughout and, anteriorly, in the region of the cancellous bone into which the frontal sinus should have grown, resorption has failed and the frontal sinus is in consequence markedly hypoplastic. The anatomical relationship between the "supra-ciliary" canal and the area of bone into which the frontal sinus should have extended, is demonstrated by a fine steel wire, placed in the canal.

Throughout the vault of the skull, the diploic hypoplasia is more evident where the blood supply is anatomically less, normally, and conversely, the hypoplasia is less where the diploe is normally thicker and more vascular, *i.e.*, in the parts overlying the cerebral sulci, where communicating vessels pass from the dura mater to the diploe. Thus the appearance is created of "convolutional impressions" on the vault (Fig 10, No 931). These have not been produced by pressure atrophy, but have occurred passively and are due to the

year. The calvarium has been transilluminated to show the convolutional impressions. The cancellous bone in the frontal area, into which the frontal sinus should normally extend, has been injected from the "supra-ciliary" canal. Its vessels are continuous with those in the diploe elsewhere. Dog No 555. Depancreatized as young adult, hypophysectomized twelve days later, skiagram 7 months thereafter. Note the very marked obliteration of the dental pulp cavities.

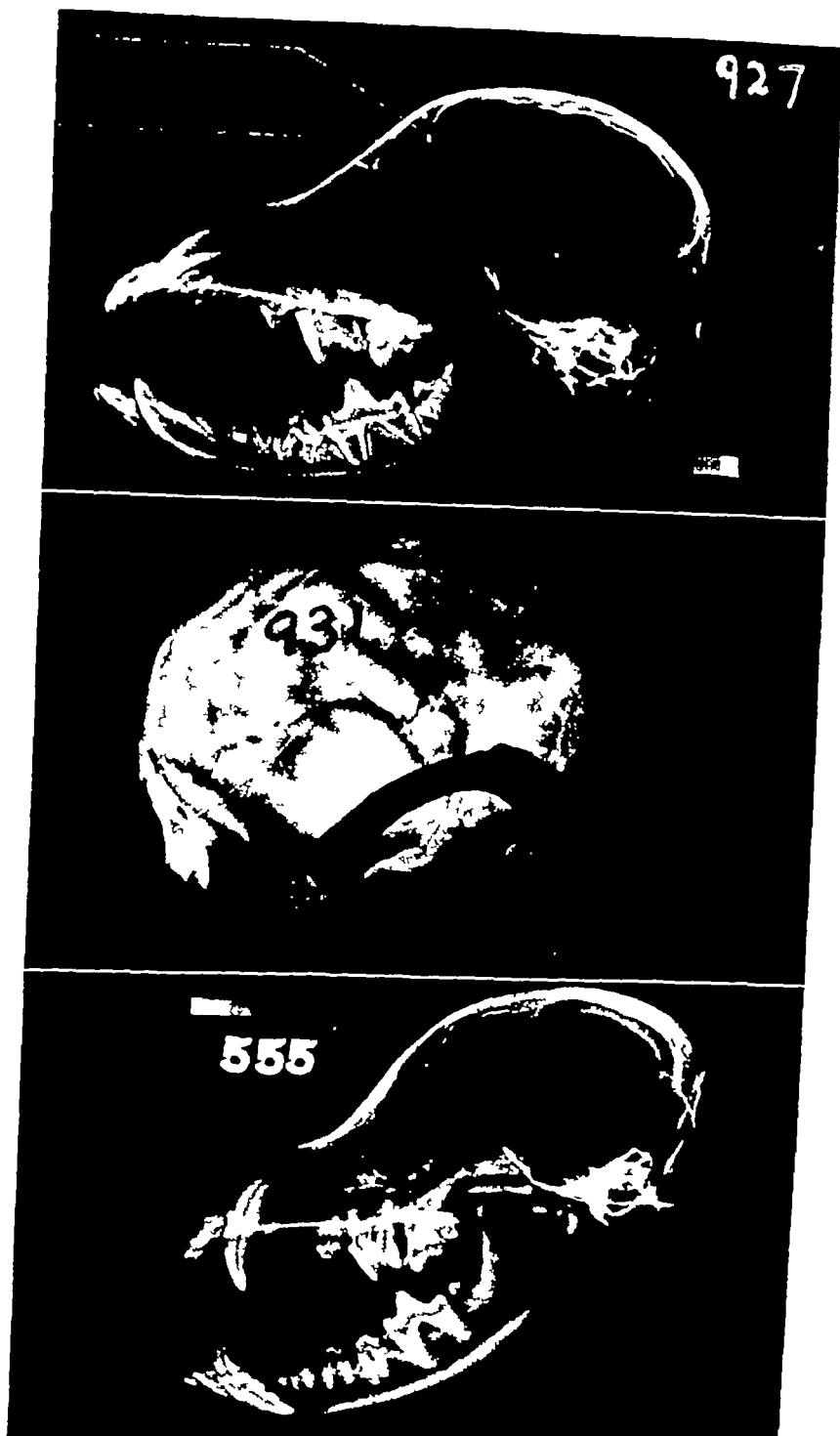


Fig 10 The effect of hypophysectomy on the cranium of the dog Dog No 927 hypophysectomized about the fifth week of life. Skiagram one year later A, Position of 'supra-ciliary' canal with metal stilette in it B' Upper limit of hypoplastic frontal sinus beyond which is cancellous bone. Dog No 931 Another animal of same series hypophysectomized about the fifth week surviving one

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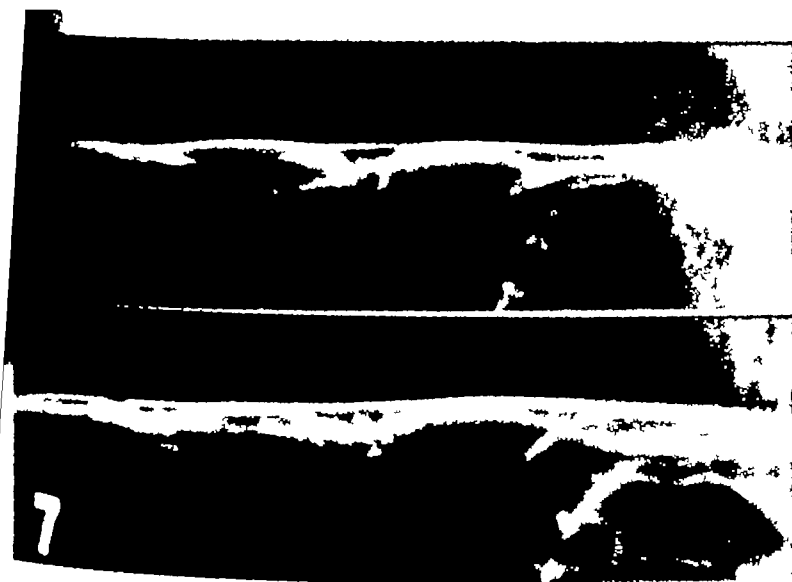


Fig. 10. The control rat skull (top) and the hypophysectomized rat skull (bottom). Comparison of the skulls of the control and hypophysectomized rats. Note the difference in the shape of the skull.

to survive 218 days. No. 11 is 210 days of age and weighs 22g. The former shows the development of hypophysectomy performed at that stage in growth. No. 12 is another male hypophysectomized at this stage subsequent to which it was fed with a highly purified growth medium (Q. 21.A) for two months. The calvarial outline is that of an animal more advanced in development than the untreated animal, the molar teeth being observed to be better grown, the height of the middle table in the frontal bone, but it could even be considered excessive. In the parietal bone, the homologous area is not only normal but appears to be larger than normal. Above it there is an indication of a frontonasal angle, the region the skull is better calcified in the untreated animal. There

in the untreated animal in the basisphenoid there is complete healing of the trochlear opening, whereas this defect is still present in the untreated animal.

The incisor tooth in the treated animal is a source of very important information. Were this structure not included in the skigram it would be impossible to tell that the animal had ever been hypophysectomized, since the rest of the cranium has completely recovered. The anterior two-thirds of this tooth, however, still indicate clearly that this operation had been done. There has been, however, almost complete recovery in the proximal part of the "root" of the tooth which is normally tapered and the pulp cavity in this situation is almost entirely normal. There is, however, a marked indentation present on the anterior surface of the root, the part proximal to which represents the portion grown during the hormone treatment.

It has not been found possible so far to continue treatment until a completely normal tooth results, since, with continued injections, the hypophysectomized animal,

Fig 11

Fig 11 The effect of untreated hypophysectomy No 2 Male hypophysectomized on the forty-seventh day Skiagram taken at 237 days, as compared with skiagram of slightly younger normal male: 210 days

Fig 12

Fig 12 The effect of treatment with Q hormone on the hypophysectomized rat (Purified somatotrophic hormone.) No 7 Male hypophysectomized on the forty-seventh day, treated twice daily for 53 days No 2 Male hypophysectomized on the forty-seventh day, no treatment

fact that a general diploic hypoplasia produces its greatest apparent effect in areas in which the bone is normally thinnest, *i.e.*, over the convolutions

To a less degree such an appearance is more or less characteristic of young crania, or at least of crania which are thin, with the middle table of the skull poorly developed. In this instance the appearance is produced first by the retention of an infantile characteristic, subsequently enhanced by diploic atrophy

An effect of the same order is apparent to a less degree in the skiagram of the "Houssay dog" (pancreatectomized-hypophysectomized), a photograph of which has been published by Collip (16). This animal, a female of mongrel "terrier" stock, was sexually mature when the pancreatectomy was done, hypophysectomy followed 12 days later, abortion following the second operation. She was killed after seven months, when the skiagram (Fig 10) was made. Since there was no control animal, it is impossible to be certain to what degree the shortness of snout is due to the hypophysectomy. However, the presence of a well marked prognathism, the incisor teeth in the mandible overshooting the upper teeth, definitely indicates failure in

forward growth of the pre-maxillary part of the snout, as does the incomplete development of the frontal sinus. This is about half its normal size, the part of the bone in the supra-orbital region into which it normally extends, in the dog, being still marrow-containing cancellous bone. The conclusion is justified that the animal, although sexually mature, and pregnant when the experiment began, was not completely grown, and that the cranial development was arrested by hypophysectomy

The dental condition is extremely interesting, there is not only marked malocclusion and deformity of certain roots, but the pulp cavities of all the teeth have suffered an extreme degree of obliteration, those of the canine teeth being vestigial. Postmortem in this animal there was found parathyroid atrophy, a condition found, by Houssay (17) and Collip (8), to occur in dogs so treated

The Effect of the Administration of Purified Somatotrophic Hormone on the Cranial Defects Produced by Hypophysectomy—The crania of 21 hypophysectomized animals, treated with various batches of purified somatotrophic (growth) hormone (13 and 14), were examined. The routine test object for such hormone-fraction is the rat

hypophysectomized when it weighs about 100 grams Rat No 2 (Fig 11) is a male, hypophysectomized at 47 days (98 grams)

has been complete recovery of the bones of the cranial floor in marked contrast to the poorly expanded state of those structures

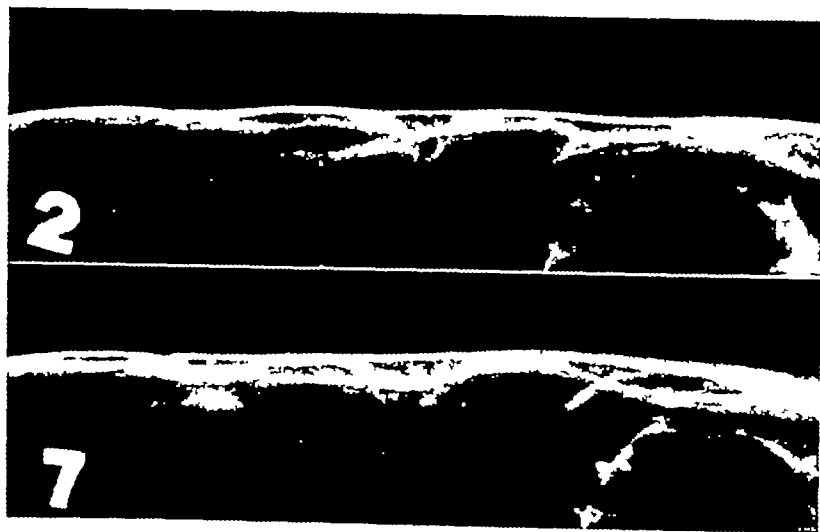


Fig 13 The effect of purified somatotrophic hormone on the frontal sinus homologue. Comparison of the diploe and frontal sinus homologues in hypophysectomized—untreated and hypophysectomized—somatotrophic hormone treated rats Note the recovery in the latter

and allowed to survive 238 days No 9 is a normal male, 210 days of age and weighing 315 grams The former shows the defects typical of hypophysectomy performed on an animal of that stage in growth No 7 (Fig 12) is another male, hypophysectomized at this stage, subsequent to which it was treated with a highly purified growth fraction (Q 40 A) for two months

The defects have largely been made good The calvarial outline is that of an animal markedly more advanced in differentiation than the untreated animal, the snout is better grown, the height of the snout above the molar teeth being obviously greater There is not only complete recovery of the middle table in the interparietal bone, but it could even be considered excessive In the parietal bone diploe can be seen, while anteriorly the frontal sinus homologue is not only normal in size, but appears to be larger than normal (Fig 13) Above it there is an indication of the formation of a frontonasal angle, and in this region the skull is better calcified than in the untreated animal There

in the untreated animal, in the basi-sphenoid there is complete healing of the trephine opening, whereas this defect is still present in the untreated animal

The incisor tooth in the treated animal is a source of very important information Were this structure not included in the skiagram, it would be impossible to tell that the animal had ever been hypophysectomized, since the rest of the cranium has completely recovered The anterior two-thirds of this tooth, however, still indicate clearly that this operation had been done There has been, however, almost complete recovery in the proximal part of the "root" of the tooth, which is normally tapered and the pulp cavity in this situation is almost entirely normal There is, however, a marked indentation present on the anterior surface of the root, the part proximal to which represents the portion grown during the hormone treatment

It has not been found possible so far to continue treatment until a completely normal tooth results, since, with continued injections, the hypophysectomized animal,

treated for more than 30 days with a purified growth extract, ceases to manifest any further growth response (15)

The Influence of Hormone Factors on Cranial Structure—We have already indicated, in noting that the earlier in life an animal is deprived of the influence of the anterior pituitary upon growth the greater is the resultant, characteristic deformity, that its cranium may serve as a criterion in judging the normality or abnormality of the growth process in the past, and that deformity may serve as an index to the time of occurrence of a retarding influence. To be considered as normal, the cranium must have attained a certain size relative to the age and sex of the animal, and its component parts must bear a certain proportion relative to each other. But in addition, those individual components at any given time in growth, whether during the active phase or later in adulthood, must present a certain density, relative to their architectural function.

In the earlier stages of growth the cranium is relatively less calcified and its calcium is more mobile than when active growth is over. This facilitates the "expansion" which progressively characterizes bone in growth, but as the process proceeds and the final architectural pattern is completed, there follows a period in which the tissues become more heavily calcified, so that consolidation of the structure takes place and this is reflected in the skiagram as an increasing density, more especially marked in certain areas where functional stress occurs. But it has been shown, in the normal healthy animal, that this structural density cannot in any way be regarded as "permanent." Calcium and other salts are constantly being lost and replaced, so that even when dimensional growth is over and the fully adult form achieved, growth can be considered still to be taking place at a vegetative or maintenance level. Chiewitz and Hevesy (18) have estimated that the average time which a phosphorus atom remains in the organism of a normally fed rat is about two months and they conclude that the

formation of bone is a dynamic process, the bone continuously taking up atoms which are partly or wholly lost and replaced by others. They also demonstrated that, with a given intake, rapidly growing structures, such as the incisor teeth, take up atoms to a greater extent than others, like the molar teeth, which, once erupted, take up less than the average per gram of skeleton.

The level at which such mineral interchange maintains a positive balance accounts for the variations in density that are to be found at all ages in an animal of such pure and stable stock as the white rat. In the adult rat, as in man, the tendency with advancing age is not toward demineralization but toward a progressive increase in density, particularly noticeable in the male animal.

Apart from pathologic processes there are many general conditions which are admittedly capable of producing change in bone density, and the means by which they act may not always be clear, but the influence of hormones on calcium metabolism is specific and of prime importance.

Scientific investigation of calcium metabolism in man is a matter of much difficulty, chiefly due to the wide range of the materials constituting his diet and the reluctance with which he will submit himself to subsistence for sufficiently long periods of time, upon the type of diet which makes the estimation of the calcium balance practicable. The rat, however, is an ideal animal for this work for which it has been in extensive use. We have had an opportunity of radiographing the crania of a certain number of rats used in the various investigations of calcium metabolism conducted by workers in this laboratory. Thus it has been possible to be assured not only of the physiologic normality of the animals in use, but of the exact daily intake and elimination of calcium for several weeks prior to the period of experimentation, at the end of which it has been possible to correlate the radiographic appearance with the recorded measured effects of the treatment upon the animals' calcium metabolism.

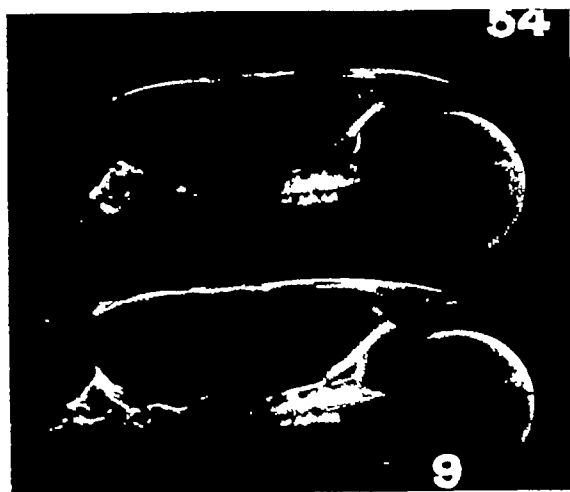


Fig 14

Fig 14 The Effect of thyroid by mouth on cranial density No 54, age 212 days, weight, 136 gm, male Two gr desiccated thyroid, daily by mouth, for 18 days, during which period there was a loss of weight of 34 gm No 9 male, age, 210 days, weight, 315 gm

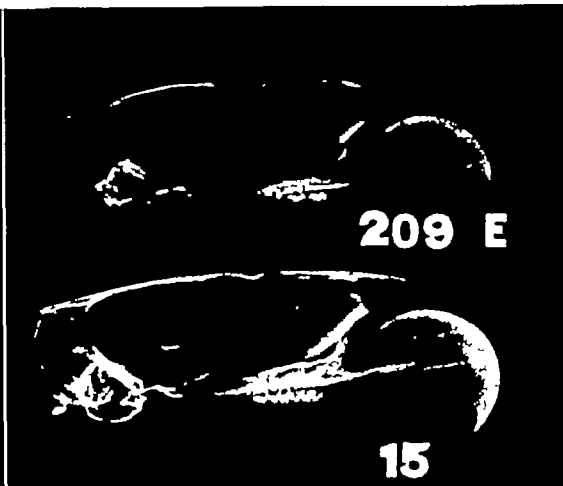


Fig 15

Fig 15 The effect of thyreotropic hormone on cranial density No 209 E Treated with T G 12, twice daily for 55 days, age, 87 days, weight, 138 gm No 15 Untreated, age, 91 days, weight, 140 gm Both are intact animals

(A) FACTORS PRODUCING DEMINERALIZATION (OSTEOPOROSIS SIMPLEX)

(1) *Thyroid Feeding*—No 54 (Fig 14) is the skiagram of one of a series of rats investigated by Pugsley and Anderson (19), it is a male 212 days old, the control being a normal male two days younger For 45 days prior to treatment it was upon an otherwise normal diet in which the calcium content had been reduced to nearly balance the calcium excretion, the animal being in a positive Ca balance of 2.7 mg per day It was then given two grains of desiccated thyroid gland daily by mouth for 18 days The skiagram shows a well marked general demineralization in the cranium and teeth, particularly noticeable along the vault, in the petrous portion of the temporal bone, and in the frontonasal region, where the effect is to make the anterior component of the frontal sinus homologue appear relatively enlarged Careful inspection, however, reveals the fact that it is not larger than in the control, but that the area over it, in the treated animal, being less dense, has been more completely penetrated The tooth changes are noticeable both in the molar and incisor teeth In the latter,

at first sight, the difference in general density does not appear to be very marked, but comparison both of the thickness and density of the dentin of the anterior wall near the "root" shows clearly the change, there is a well marked decalcification of this area in the treated animal It may be as well to point out that without the penetrometric standard on both skiagrams one might hesitate in attaching full significance to the above changes One is further strengthened in reading the above skiagram by reference to the physiologic findings Dr Pugsley found that during the period of treatment in this particular animal the fecal calcium output rose from 4 to 10 mg per day, and that the animal was in a negative calcium balance of about 5 mg daily In this group of six rats, whose body weight averaged approximately 250 gm at the beginning of the experiment, about 70 gm were lost under thyroid treatment This animal, treated for a considerably shorter period, lost 34 grams The calcium lost is chiefly eliminated in the feces, although there is a decided increase also in the excretion of calcium in the urine During treatment the basal metabolic rate rose progressively, thus accounting for the loss

in weight, while the general cranial demineralization, seen in the skiagram, is accounted for by the negative calcium balance

(2) *Thyreotropic Hormone*—Although the hypophysectomized animal is, in certain respects, more responsive to the administration of a purified thyreotropic fraction than the intact animal, it presents the disadvantage, as has been shown, of having a profound cranial dysplasia, in the presence of which it is hard to distinguish a specific thyreotropic influence. The crania of 36 intact young adult rats treated with thyreotropic hormone in relatively large dose, twice daily, and for varying periods of time, were examined

No 209-*E* (Fig 15) was one of a group of six rats so treated for the last 55 days of life, by Dr Anderson (20). Compared with the control animal which is four days older, and but 2 gm heavier, it shows a marked general demineralization of the cranium and teeth. The cranial proportions are normal and there certainly is no evidence of overgrowth, the animal is intact. Even on the administration of this hormone fraction, in this laboratory, to the hypophysectomized animal there has thus far never resulted any growth (8), nor is there any evidence of interference with growth, as far as this can be inferred from body weight, for during the period of treatment the record shows that it gained 105 grams. In another group of animals similarly treated, Pugsley (21) was able to show that there resulted an increased elimination of calcium in the feces during the period of elevation of the basal metabolism. The animals, however, were not in marked negative calcium balance. It has been shown that within the first few days of such treatment the basal rate rises on the average about 35 per cent, followed by a secondary rise in about a week which, however, is not maintained. The rate gradually subsides, despite the continuance of treatment, to normal or below normal. Collip suggests that the first rise is due to the sudden discharge of existing stores of thyroid hormone into the blood, while the second results

from the glandular hyperplasia induced by the hormone

The prolonged treatment in the group including No 209-*E* resulted in the development of a condition of resistance, as shown by two facts. At postmortem this animal's thyroid was hypoplastic and weighed only 11 mg, while 3.5 c.c. of serum from the pooled blood of the six animals inhibited two hundred times the minimal effective dose of thyreotropic hormone in a hypophysectomized rat. While it might seem reasonable to presume that the acquisition of this state, which Collip and Anderson have suggested may be due to formation of a specific antihormone, with an associated thyroid hypoplasia, might be expected to result in an effect of an order opposed to the demineralization, induced by thyroid stimulation, it is obvious that this did not occur in the animals of this group, or in any of the other 30 crania examined. Without exception all showed significant demineralization. A speculative explanation of this might be found in the fact that prolonged treatment, which produces an antithyreotropic factor, is associated with a basal metabolism at a chronic subnormal level. Despite the fact that the body weights are close, one cannot altogether avoid concluding that the injected animal, due to a continued low metabolism, was the less well grown, unfortunately, there is no record as to whether it was obese or not.

(3) *Adrenotropic Hormone*—The crania of 21 young adult rats, treated with adrenotropic hormone, were examined. Dosage ranged up to 1 c.c. twice daily, over periods of from two weeks to two months. In all of them evidence of decalcification was seen, in varying degree, but there is felt to be considerable doubt as to this being a specific effect.

The hormone fractions used undoubtedly contained a certain amount of thyreotropic hormone, incidental to the extraction method, and it is possible that the effect noted is, in some measure, due to this. Otherwise the physiologic explanation of such an effect is a matter of considerable

difficulty, while a full discussion of the possibilities, at this time, is beyond the scope of the present work. It must, however, remain a matter of record that such decalcification was observed consistently in the series examined, and that it appeared markedly to affect the teeth.

(4) *Parathyroid Hormone*—It has been shown that, in various experimental animals, large doses of parathyroid hormone produce osteoclasts (22) and may even lead to the formation of osteoid tissue (23), thus simulating the osteitis fibrosa cystica of the clinical entity of hyperparathyroidism in man. In this laboratory, however, we have never seen osteoid tissue formation from parathyroid administration in large doses (24). Pugsley (25) showed that, in rats daily injected with parathyroid hormone, calcium excretion was markedly increased during the first four days of treatment, but fell to normal within from 8 to 10 days, despite continued injections. Others also observed that long continued treatment in man, as well as in animals, might lead to reduction of the serum calcium resistance being developed, and Selye (26) demonstrated that this resistance was to be explained by an osteoblastic response in the bone. It was later shown (27) that osteoclasts disappeared from the bone after about from 9 to 12 days of treatment, and that this coincided with the return of calcium excretion and serum calcium to normal levels.

In the crania of rats examined, during the short period of increased calcium excretion, we did not find any significant change, the reason for this may lie in the period of high serum calcium, and increased calcium elimination being short in the rat (which would appear to be an animal relatively resistant to parathyroid treatment). Pugsley (28) was unable to demonstrate a state of negative calcium balance in the rat under parathyroid treatment.

(B) FACTORS PRODUCING EXCESSIVE MINERALIZATION (OSTEOSCLEROSIS)

We have seen, in the normal rat, as the active growth of the cranium decelerates,

that there occurs a characteristic, progressive mineralization of the bone, which constitutes the consolidation of the structures grown in youth, this manifests itself as decreasing penetrability to the standard x-ray technic. Always more marked in the male animal, it slowly increases with senility in both male and female.

It is reasonable to suppose that at least the earlier stages of such consolidation is associated with the tapering off of dimensional growth, as full adult size is attained, to which the bone's response to stresses, imposed by full adult muscular activity, doubtless contributes. But such factors cannot be taken in explanation of the continuance of the process into late adult life, and beyond, when the tendency, especially in the male, is toward diminished muscular activity. It must then come to be considered, if not as a degenerative or pathologic process, at least as a manifestation of a diminished physiologic efficiency, it must be regarded much in the same light as the increasing percentage of fat in the carcass with age (29), as a manifestation of an involutional process. That this is normally associated with the level of pituitary function is clear from the work of Lee and Schaffer (30), who found that, on the administration of pituitary growth hormone, the gain in weight of injected over control animals differs very markedly in chemical composition, retaining almost exactly the composition of youth, namely, a higher proportion of water, nitrogen, fat-free dry tissue and ash, and a lesser proportion of fat, despite equality in age and diet of both injected and control animals.

In line with this is our finding that intact rats, treated with a purified growth hormone, tend to show, in the skiagram, less cranial density throughout as well as somewhat larger and more highly developed crania than their controls, so that the radiopacity more resembles that of somewhat younger animals. Pugsley (21-B), studying the calcium metabolism of such animals, found that the somatotrophic hormone did not alter either the serum calcium level or the calcium balance, whereas in the hy-

pophysectomized rat the effect of this fraction was to restore the calcium balance, previously negative, to normal level. In the untreated hypophysectomized rat, as has already been shown, a relative sclerosis occurs in time, since salts are slowly added to a structure in which resorption is markedly depressed.

The hormones which we have found to exercise an influence in demineralizing the cranium are largely dependent on the functional activity of the anterior pituitary, which specifically stimulates both the thyroid and the adrenal cortex. Whether or not the parathyroid glands also are dependent upon a specific stimulus from this gland would still appear to be in some doubt. Houssay (32) found a cellular atrophy in the parathyroid glands of the dog, following hypophysectomy, although the blood calcium level was not altered, "probably because the parathyroid lesion is partial," but he found that anterior pituitary extract increased the size of the parathyroid glands and their content of clear cells, raising also the serum calcium. This latter, however, does not rise if the dog has been previously parathyroidectomized. Pituitary extracts are without influence on the hypocalcemia and tetany, which follow the operation, and the results following thyro-parathyroidectomy are the same in both the hypophysectomized and normal dog. In pancreatic insufficiency in the dog, in from three to seven days after operation, the blood calcium falls to from 7 to 9 mg per cent, and once this has taken place insulin is not wholly effective in returning the level to normal or in restoring the histologic structure of the parathyroids.

Houssay found, however, in dogs in whom both hypophysis and pancreas are removed, that the parathyroid lesions, although of the same order as those produced by pancreatectomy alone, were much more severe, a fact which Collip (8) confirmed. As to the latter damage he views it as possibly resulting from nutritive disturbances, associated with the diabetic condition, whereas, in the hypophysectomized-depancreatized animal, he regards the more

severe effect as possibly due to the lack of a parathyreotropic hormone, which may or may not be specific. It must be borne in mind, however, that complete proof of the existence of such a hormone is still lacking.

(1) *Prolonged Parathyroid Administration*—It has been shown (24) that long continued administration of parathyroid hormone produces resistance in the injected animal, with improvement in its clinical condition. During this stage osteoclasts disappear, there is a proliferation of numerous osteoblasts with new bone formation. Selye (26-A) found that, if treatment is begun with a very small dose, new bone formation may result immediately, without preliminary bone resorption. Such bone deposition is always much more marked in the intact rat. Even in the hypophysectomized animal, formation of new bone takes place, but only after about fourteen days of treatment. Prior to this there is evidence that bone resorption is active. Thus, it would appear that parathyroid extract—or more properly speaking, the resistance developed as a result of prolonged parathyroid treatment—may lead to bone deposition whether the hypophysis is present or not.

In the preliminary investigation of the effect of prolonged parathyroid hormone administration on the rat cranium, samples were taken from a current series of animals that were being injected with two units of "parathormone" twice daily, treatment having commenced on the thirtieth day of life.

The first animal (No. 242-A) was examined after 30 days' treatment, the cranial skiagram showed definite "sclerosis," particularly in the tympanic bulla and in the calvaria. This was confirmed by Dr. Selye's independent report from histologic examination of the lower end of the femur.

Another (No. 242-B), examined after 45 days' treatment, showed considerably more sclerosis of the skull, affecting most the calvaria and the tympanic bulla, the walls of the incisor teeth were thicker and denser. Histologically, the lower end of

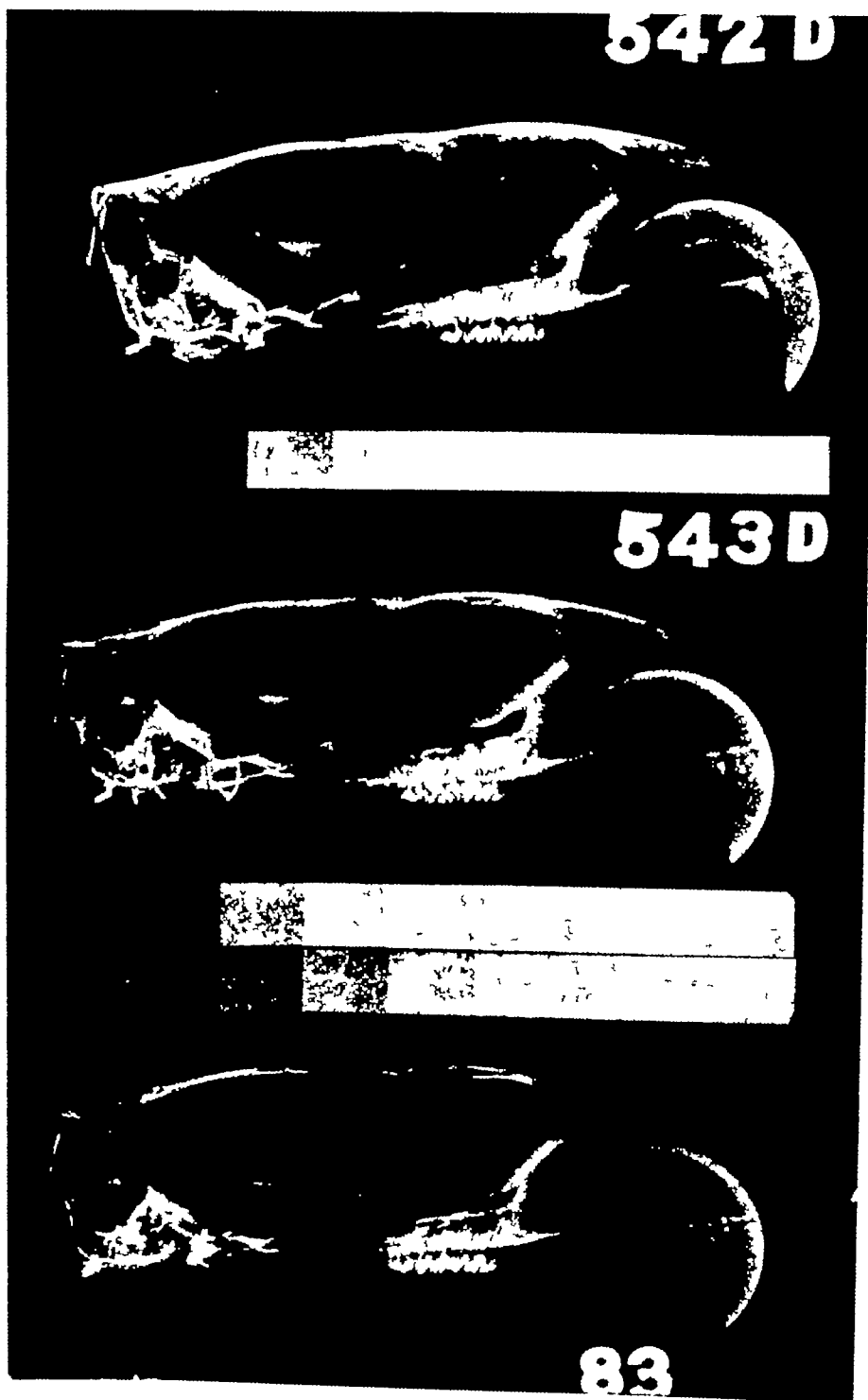


Fig 16 Effect of prolonged parathyroid hormone treatment and prolonged parathyroid plus thyreotropic hormone treatment on the intact rat cranium
 No 542 *D* treated with two units parathyroid hormone, twice daily, for 56 days
 Age at death, 86 days, weight, 157 gm
 No 543 *D* treated with two units parathyroid hormone plus 0.5 cc thyreotropic hormone, twice daily for 86 days Age at death, 116 days weight, 154 gm
 No 83 normal control Age at death, 84 days, weight 198 gm

the femur showed the condition described as "marble bone"

A third (No 242-D, Fig 16), skiagraphed after 56 days' treatment, showed a still more marked cranial sclerosis, particularly outstanding in the tympanic bulla

None of these animals showed, histologically, any endocrine abnormality, and all these organs were within normal limits in weight

Three rats were also examined as samples of another series, of the same age as the parathyroid-treated series, and receiving also from the thirtieth day of life the same dose of parathyroid hormone with, in addition, thyreotropic hormone twice daily, in doses of 0.25 c.c. for the first two weeks, thereafter raised to 0.5 c.c. twice daily

The first (No 543-A) was examined after 27 days of this treatment. The skull was even somewhat less dense than usual, and, for this reason, there was some doubt as to its normality. The tympanic bulla was normal

The second (No 543-B), examined after 45 days' treatment, showed a cranium unmistakably sclerosed. Histologically, there was independently reported to be "osteoblastic response" in the lower end of the femur. The tympanic bulla was definitely increased in density. It appeared as if the thyreotropic effect was not particularly clearly marked in this cranium, which was almost as dense as that of the animal treated for 45 days with parathyroid hormone alone

The third sample (No 543-D, Fig 16) was not examined until after 86 days of treatment with the two hormones. This was found to show only a very slightly greater degree of sclerosis than the cranium of the animal treated for 56 days with parathyroid hormone alone. The tympanic bulla is only moderately affected. The calvarial sclerosis, seen in the skiagram, is confirmed independently by Dr Selye's histologic report, which describes the condition as "sclerosis of skull". The endocrine glands were normal both histologically and in weight

The animals of the above two series were

on the normal laboratory diet, with a normal calcium-phosphorus ratio. From the confirmation of the radiographic appearances by histologic examination, both of crania and femoral ends, even although the number of animals examined is small, it would appear that, under certain conditions, small doses of parathyroid hormone, administered for relatively long periods, induce a state of resistance to the parathyroid hormone which may be characterized by a general cranial sclerosis, most apparent in the calvaria and tympanic bullae

Also, it would appear that the degree of this excessive mineralization is, to some extent, limited by the administration of the thyreotropic fraction of the anterior pituitary, which effect we have shown to be one of demineralization, together with the parathyroid hormone

Confirmation of the sclerosing effect of long continued parathyroid treatment upon the skull of the rat was obtained in an experiment designed to show the effect of this hormone when given alone, in contrast with its effect, when given simultaneously with a somatotrophic pituitary fraction (24). Forty rats, from 40 to 50 days of age, half of which were hypophysectomized just before the experiment was begun, were divided into four groups. The first group received a graded daily dose of parathyroid hormone starting with one unit and increasing by one unit every day until the eighth day, after which they received eight units daily. The second group was treated with 0.5 c.c. of an active purified growth fraction of anterior pituitary. The third group received the same doses of both growth and parathyroid hormone as the first and second groups, while the remainder served as intact and hypophysectomized controls. Each group consisted of the same number of intact and hypophysectomized animals and treatment was begun on the same day in all, namely, on the day after operation of those hypophysectomized. Animals were examined after 8, 18, and 28 days' treatment by histologic section of the lower end of the femur, and the crania were skiagraphed after dissec-

tion In a certain number of cases the cranium also was examined histologically

Parathyroid-treated Rats—In the intact animals the cranial skiagram shows a suggestive increase in density after eight days, at which time the hypophysectomized animals showed no change, and, histologically, there was a mixed osteoclastic and osteoblastic response After 18 days of treatment, the intact animals showed a well marked sclerosis, while the histologic picture was that of an osteoblastic response, a similar condition being seen after 28 days In the hypophysectomized animals, the skiagrams showed little change, although the general appearance now showed that the animals had been hypophysectomized After 28 days of treatment, commencing sclerosis was apparent and, histologically, there was an osteoblastic response in the skull as well as in the femur It would appear that sclerosis in response to this treatment occurs not only in the intact, but also, although more slowly and to a less degree, in the hypophysectomized rat

Somatotropic-treated Rats—After eight days of treatment the intact animals could not be distinguished in the skiagram from the controls After 18 days there was apparent "growth effect" in the calvaria and in the frontal sinus homologues Histologically, the long bones of these animals were described as normal In the somatotrophic-treated, hypophysectomized animals, even eight days after operation there was evidence of growth when compared with their hypophysectomized controls This was still more clearly marked after 18 and 28 days of treatment The histologic picture in the long bone was described as "porotic" Comparing the hypophysectomized and the intact animals in this group, treated with "growth" hormone, it was evident from the cranial skiagrams that the response was not only more clearly seen, but relatively greater in those hypophysectomized

Animals Treated with Both Parathyroid and Somatotrophic Hormone—In the intact animals, after eight days of treatment, no distinguishable change could be seen Af-

ter 18 days there was both a growth hormone effect and a doubtful increase in density, after 28 days, while the growth influence was still apparent, density was more clearly increased At both these stages, "marble bone" was reported in the femora In the hypophysectomized animal there was no evidence of any sclerosis until after 28 days of treatment, while the influence of the growth hormone could be seen from 14 days onward and in certain cases at eight days Histologically, there was an "osteoblastic response" from eight days of treatment onward It would appear that the effect of parathyroid hormone, when given with growth hormone, is less marked in both the intact and hypophysectomized animal, than when given alone In the earlier killed animals the growth effect is more clearly in evidence, the cranial sclerosis occurring only later, and being considerably less in the hypophysectomized animal than in the intact In both, it would seem to be less than in similar animals treated for an equal length of time with parathyroid hormone alone

(2) *Prolonged Treatment with Crude Alkaline Extracts of Anterior Pituitary*—It has been found, in certain cases of dogs treated with relatively crude alkaline extracts of the anterior pituitary, that, apart from growth, glycosuria or obesity may result (32) Rats so treated show increased acetone bodies in the blood (33), and large quantities are excreted in the urine in the fasting animal (34) The mode of production of such diabetogenic and ketogenic effects is not known While it has been held that the fat metabolism hormone is an entity, separate from the growth, thyrotropic, and gonadotropic principles (35), it has to be kept in mind that the diabetogenic and ketogenic principles may be one and the same, and indeed that they may well be merely special physiologic effects of one, or even more than one, of the known anterior pituitary hormones (8)

Our interest in this question arises from our observation of the high frequency of calvarial sclerosis in women who show well marked obesity, and the opportunity arose

of examining the crania, both during life and postmortem, of the rats used by the late Dr Peter Black in the investigation of

life. Two of these showed absolutely normal crania, in three the density was questionably greater than normal, while in only

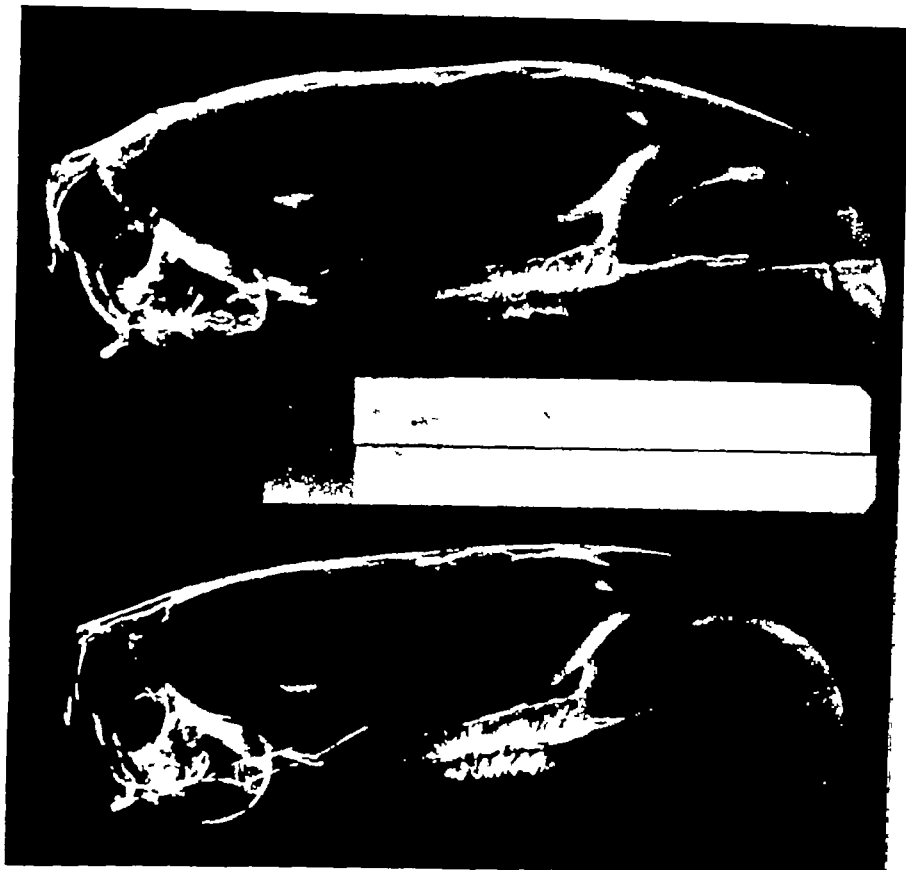


Fig 17 See caption on opposite page

hormones experimentally producing ketosis

In his series we examined 13 animals treated for various periods with Burn's modification of Evans' extract, in which 1 c c represented a fifth of a gram of ov anterior lobe, the dose ranged from 0.25 to 2 c c twice a day, given intraperitoneally

Six of the animals were intact males, treated from the sixty-eighth day of life with doses beginning with 0.5 c c and rising, as the urinary ketone output tended to fall, tested while fasting to 2 c c twice a day, treatment lasting for 77 days and the cranial skiagram being taken of the living animal on the one hundred forty-fifth day of

one was there a condition which one could regard as abnormally dense. It is interesting to note that this animal showed a body weight at the end of the experiment well above normal, and obesity

Three younger intact females were treated for 100 days, beginning at the thirty-fifth day of life, with, however, a lesser dose, the increase being to 1 c c, twice a day, as resistance to the ketogenic effect became apparent, two of these showed a doubtful sclerosis compared with control material, and one showed no change at all

Four hypophysectomized rats, three males and one female, were treated for periods of from 120 to 159 days. Operation

was performed on the eightieth day of life in the three males, treatment began 10 days later, the dose ranging from 0.25 to

It will be seen from this (Fig. 17) that growth has chiefly taken place in the brain-case. The increase in both density and

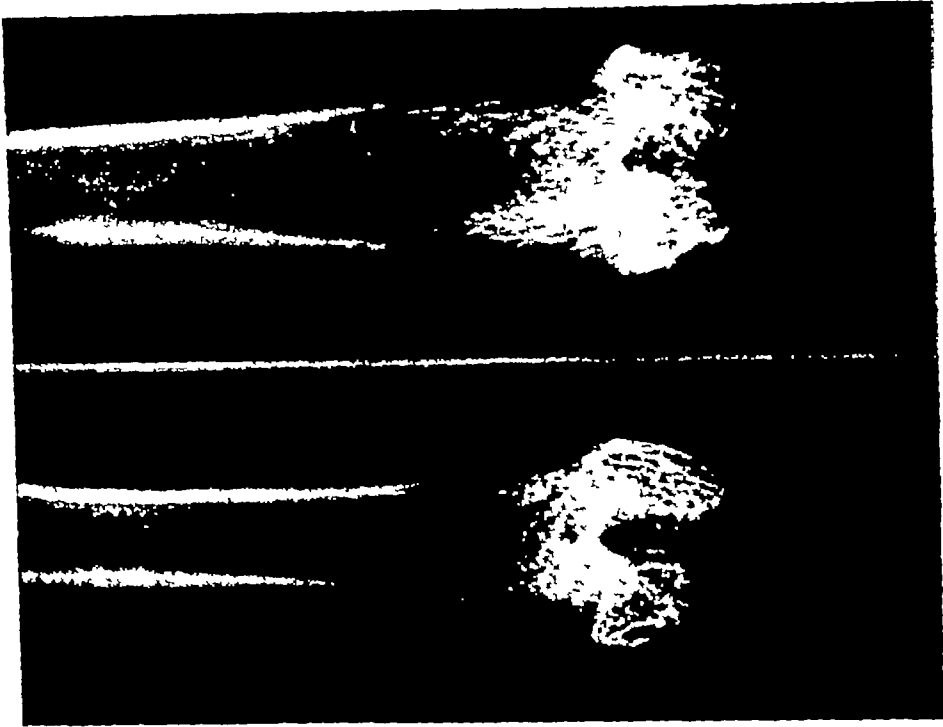


Fig. 17 Effects occurring with resistance induced by prolonged treatment with crude alkaline extract of anterior lobe, in hypophysectomized rat
'A' and 'C' cranium and lower end of femur of a hypophysectomized, treated, animal
Treatment 120 days Female, age 196 days, weight 353 gm
'B' and 'D' cranium and femur of female litter-mate control Age, 196 days weight 163 gm

2 c.c. twice a day. The gain in weight which resulted from this treatment was very markedly greater than in the intact animals. The crania showed most obvious sclerosis, especially in the calvaria. This seemed to be, to some extent, in proportion to the gain in body weight; obesity in these rats was well marked. In the case of the female hypophysectomized animal, treatment was given for a month prior to hypophysectomy and continued for three months after operation. While in the intact rats the skiagrams show no great change in cranial density, a very marked increase was apparent in thickness and in density of the calvaria before the treatment ended; this was confirmed by the skiagram taken after dissection.

thickness of the calvaria is striking, and the effects of hypophysectomy are largely recovered from, except that the snout has lagged somewhat in forward growth. The incisor tooth has almost recovered, especially in its proximal third, although in the distal half there is still evidence, in the thickening of the anterior wall and consequent restriction of the pulp cavity, that this animal had been hypophysectomized. Also, the general form of the tooth is not normal; its semicircular form, instead of being somewhat closed at the extremities, as occurs after hypophysectomy, is opened out so that the chord of its arc would appear to be longer, and not shorter, than normal.

One feels justified in concluding that in

the intact animal prolonged treatment with a crude alkaline, anterior pituitary extract can lead to a dimensional overgrowth, with a tendency to obesity and a fall in the ketone output, in the urine, when the animal is fasted, due to a state of resistance, but that the cranium is only very slightly affected, if at all. The slight increase in density observed may be accounted for by the fact that the animal has merely a stouter bony structure, entirely compatible with the general growth effect.

In animals treated after hypophysectomy, however, it would appear that growth is abnormal, both in amount and in mode. A female rat (Table II) was treated for one month prior to hypophysectomy, and treatment continued for three months after operation, which was performed on the seventy-sixth day of life. At death, when 196 days old, it weighed 353 grams against 163 grams, the weight of a litter-mate control of the same sex whose cranium is also shown (Fig. 17). Table II, in which their cranial measurements are compared, brings out the nature of the change. The treated animal's skull is 10 per cent longer than the control's, and this would appear mostly to be due to excessive growth of the brain-case, which is almost 15 per cent longer than in the control. The nasal bone lengths, however, show only a difference of 3 per cent, a fact of probably slight significance.

As in the cranial growth of the animal hypophysectomized at a very early age,

cranial height and width would appear to retain normal measurements, the disproportion, in brain-case growth—in this case on the side of excess—affecting chiefly the anteroposterior dimension. The nasal bone length, while slightly in excess of normal, when compared with the control, is deficient when taken relative to the length of the brain-case, in which respect it may be regarded as still retaining the defective proportion of the hypophysectomized animal. The adoption of this view is aided by the evident retardation in incisor tooth eruption which, above, is 19 per cent less in length, the lower tooth not suffering so markedly. Further indication of serious disturbance in harmonious, proportionate growth, in the snout itself, is evident in the fact that, despite the inadequately erupted teeth, there has been more than adequate forward growth of the jaws, between the incisor and molar teeth, indicated by a 7 or 8 per cent greater length in the diastemata in the treated animal.

Cranial capacity has been increased "passively," it is suggested, to meet the needs of a brain which has shared in a general overgrowth of soft tissues, as a result of treatment, but "active" differential growth in the snout, in line with this, has not taken place, and there is an associated failure in tooth growth and eruption, which possibly may stand in an effect relationship to this failure. The sclerosis may be due not only to an absolutely increased acquisition of salts in the bone tis-

TABLE II—CRANIAL DIMENSIONS OF HYPOPHYSECTOMIZED RATS AFTER PROLONGED TREATMENT WITH KETOGENIC HORMONE (BURN'S EXTRACT) COMPARED WITH LITTER-MATE CONTROL OF SAME SEX

	Control	Treated	Difference Percentage
1 Total cranial length	44 mm	48.5 mm	10.2% Plus
2 Fronto-occipital length	27	31	14.8 Plus
3 Nasal bone length	17	17.5	3 Plus
4 Cranial height	11	11.25	2 Plus
5 Cranial width	15	15	
6 Upper incisor length (extra-alveolar)	8	6.5	18.8% Less
7 Lower incisor (extra alveolar)	12	11	8.4 Less
8 Upper diastema	12	13	8.3% Plus
9 Lower diastema	7	7.5	7 Plus
10 Cranial weight	182.76 gm	248.76 gm	36% Plus
11 Body weight	163 gm	353 gm	116.5% Plus

Total cranial length is arrived at by adding nasal bone length to fronto-occipital length in order to eliminate the error produced by the difference of the frontonasal angles in measuring naso-occipital length with calipers.

sue, but also, and perhaps more especially, to a relative increase, in turn due to failure of the process of resorption to keep pace with deposition. It is felt that this may be an important factor in retardation of tooth eruption, the teeth becoming "incarcerated."

The failure of this process of resorption, consequent upon the absence of the anterior pituitary, deprives the mechanism of growth of the most essential factor concerned in that form of harmonious change and adjustment that is called "modelling." Animal stocks, which for long have been both carefully bred and protected in their environment, increasingly show a perfection of morphologic structure and proportion. A good example of this is seen in the so-called "thoroughbred" horse in which the head is finely modelled and clean-cut. This same quality is even more outstanding in the bones of the extremities, which structurally are as light as is compatible with strength. This lightness in growth is achieved by modelling, the design of the bone becoming progressively efficient, mechanically, as the stock is improved. It is to be observed that the same factors are at work in man, although neither his breeding nor nurture are so carefully controlled.

Coarsening of the model is a significant feature in stock deterioration, and while it is undoubtedly true that there are many factors that may produce such change, it would appear that even within the lifetime of one individual the relatively normal form of the model cannot be retained in the absence of the anterior lobe of the pituitary, in spite of the fact that substitution therapy is given in an extract which would appear to contain the complete hormone content of the anterior lobe.

Comparison of the skiagrams of the lower femoral ends (Fig. 17) shows clearly the defect in modelling in the hypophysectomized, treated animal. The end of the bone is not only larger and denser, but it is coarse and club-shaped and has lost its gently sweeping curves. That it is resorption that has mainly failed is apparent not only from the excessive calcification

throughout, but also from the relatively greater quantity of dense cancellous bone in the lower end of the diaphysis.

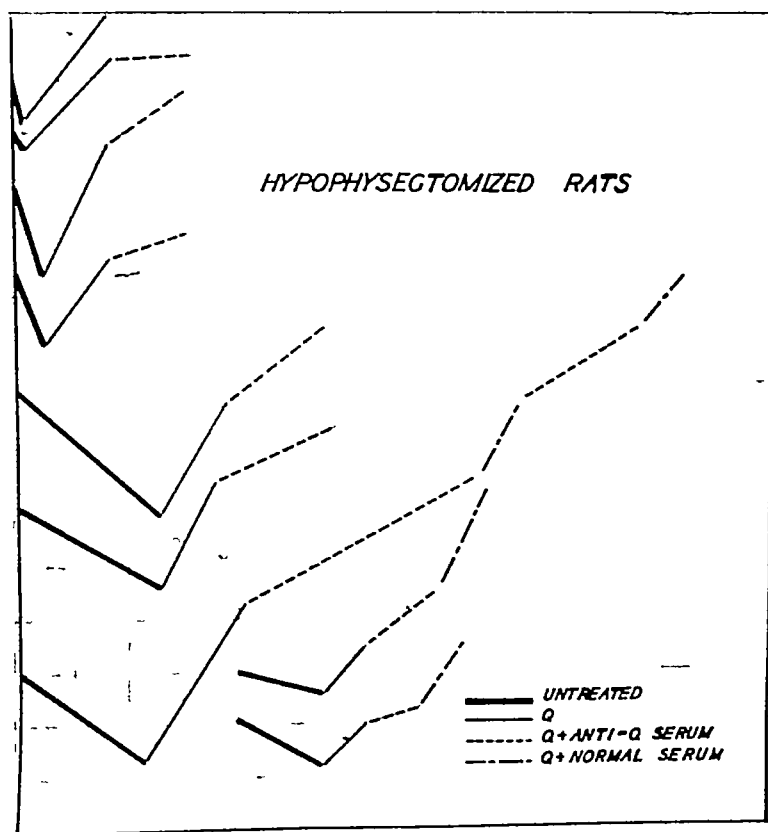
The most marked difference in the two animals is in body weight, the treated being 116 per cent heavier. Autopsy showed that this was in great part to be accounted for by a heavy fat deposit which, although generalized, was most marked on the abdominal wall and in the retroperitoneal tissue.

(3) *Prolonged Treatment with Purified Somatotrophic Hormone, when Resistance is Delayed*—When a hypophysectomized rat is treated with a crude alkaline extract of anterior lobe, there may follow an interval of a few days before any appreciable growth occurs. This is due to the presence of thyrotropic hormone in such extracts, the influence of which Collip (8) suggests is to offset the growth effect by increasing the metabolism. On administering a purified somatotrophic hormone, however, to a hypophysectomized animal, growth is immediate and may average about from two to three grams a day. With continued treatment this rate of increase can be sustained for from 30 to 35 days, when the growth curve will show a plateau effect. Thereafter, despite continued treatment, loss of weight will be evident, the animal having become resistant to the treatment.

In the case of one hypophysectomized male rat, however, growth was continuous for 77 days of treatment. This occurred in an investigation of the possibility of there being formed, in the course of prolonged somatotrophic treatment, a specific "anti-growth" hormone. A horse had been rendered presumably resistant to this hormone by daily injection of "Q 40 A" (purified somatotrophic hormone) over a period of four months, receiving in all the equivalent of 6 kilograms of ox anterior lobe. Its serum was investigated to see whether it would inhibit the effect of a somatotrophic hormone of known potency, in hypophysectomized rats. Nine male rats, hypophysectomized on the seventy-second day of life, were treated with "Q 79 F" from the thirteenth day after operation. After nine

days of such treatment they were given in addition at first 0.5 c.c. and later 2 c.c. of the horse serum together with the hormone

Nine days after hypophysectomy (Graph 1), when the animal had lost 17 grams in weight, injection of purified somatotropic



Graph 1 Survivor is No 559-A

Unfortunately, infection resulted in death of eight animals in relatively early stages of the experiment, rat No 559-A, Figure 18, being the only one to survive an adequate length of time. Equally unfortunately, it has not been possible to repeat this work owing to lack of horses as a source of serum, but it is felt that report, even of this solitary case, is justified by the markedly atypical changes occurring in the cranial structure, as the result of prolonged treatment with somatotropic hormone, and because of the apparent inhibiting effect, together with postponement of the production of resistance, associated with the periodic administration of a resistant serum with the hormone.

hormone was begun and continued for nine days. During this period, the average gain in weight was three grams daily, from the start, demonstrating hormone potency. For the next 26 days the same dose of hormone was given, first with 0.5 c.c. and later with 2 c.c. of treated horse serum, during this time the growth increment fell to 1.1 gm per day. For the next five days the same dose of hormone with 2 c.c. of normal horse serum was given daily, and the weight gain immediately rose to 2.6 gm daily. At the end of this time, the growth hormone being continued, normal serum was replaced by 2 c.c. of the treated horse serum for 12 days, during which the daily gain fell anew to just over one gram. On

the substitution of normal for treated serum, growth hormone being continued, the animal did continue to gain for a further 25 days, but only at the rate of 0.5 gm per day. Thus resistance did not appear until after 77 days of treatment, subsequent to which the animal lost six grams before it was sacrificed.

Postmortem, the body was lean, the thyroid, thymus, adrenals, testes, epididymis, seminal vesicles, and prostate were underweight and atrophic, hypophysectomy had been complete.

The cranial skiagram is of considerable interest in that it bears very close resemblance to that of hypophysectomized rats, treated to the resistance point with a crude alkaline extract, and no resemblance to any of the 20 hypophysectomized, Q-treated rats, studied radiographically. It is the only one treated with this hormone that shows sclerosis. All the others show what we have come to recognize as a characteristic "Q"-hormone effect, namely, expansion of cancellous bone, particularly the diploe. This is best seen in hypophysectomized animals after about one month of treatment. Somatotrophic treatment, continued beyond the resistance stage (for periods of from 100 to 120 days), does not produce further growth, and sclerosis has never been observed. As already stated, in the hypophysectomized animal that has responded well to "Q"-hormone, the bone structure is somewhat less dense than normal, and in fact, in animals treated for periods beyond the resistance point, the bones may be so frail as to break in stripping the cranium of its soft tissues. In this rat the Q-effect is clearly seen in the interparietal bone, whose diploe, however, is not sclerosed. Elsewhere in the diploe, the outer and inner tables are separated by a sclerosed middle table. The frontal sinus homologue is larger than in hypophysectomized animals, treated to the resistance point with alkaline extract. The tympanic bulla is dense, recovery has been excellent in the bones of the cranial base. The molar and incisor teeth have benefited; in the latter the form is almost normal—semi-

circular in outline, with just a little flattening of the anterior tooth surface at the junction of the anterior and middle thirds. The anterior wall, however, is abnormally thick and dense and the pulp cavity definitely restricted in size.

The similarity of this cranial condition in a lean animal, which despite growth is underweight for its age, to that found in rats made resistant to the ketogenic effect of alkaline extracts, in which adiposity is apt to be a feature, may be significant.

Study of the general growth process reveals the fact that it is discontinuous, that even in the period of greatest activity in youth it flows and ebbs, and there are indications that in the hormonal mechanisms, which largely control it, there is a periodicity the phases of which, of phylogenetic acquisition, carry in their activity their own decline, somewhat in the sense, although not necessarily by the mechanism, by which the products of fermentation in wine eventually inhibit the activity of the yeasts that are their source. Such balanced functional pendulum-like devices are frequent in Nature, stimulation of the respiratory center by CO₂, the apnoea that follows the "Auspumpung" effect of pulmonary hyperventilation, are common examples of the many that might be cited. They are compensatory in their function and have the inherent weakness of compensatory adjustments, that they may over-swing—to cite but one example, the fall in blood sugar that may follow ingestion of a large carbohydrate meal.

It seems not unreasonable to view the production of sclerosis in growing bone, bone indeed overgrown for a time in certain directions, from the prolonged dosage with growth hormones, as due to over-emphasis of the phase of consolidation and induced by over-swing in the first phase. That following prolonged exhibition of parathyroid hormone, the short term effect of which is to demineralize bone, may be similarly regarded, and the possibility immediately arises that the former may actually be produced by the mechanism of the latter, thus forming still one other ba-

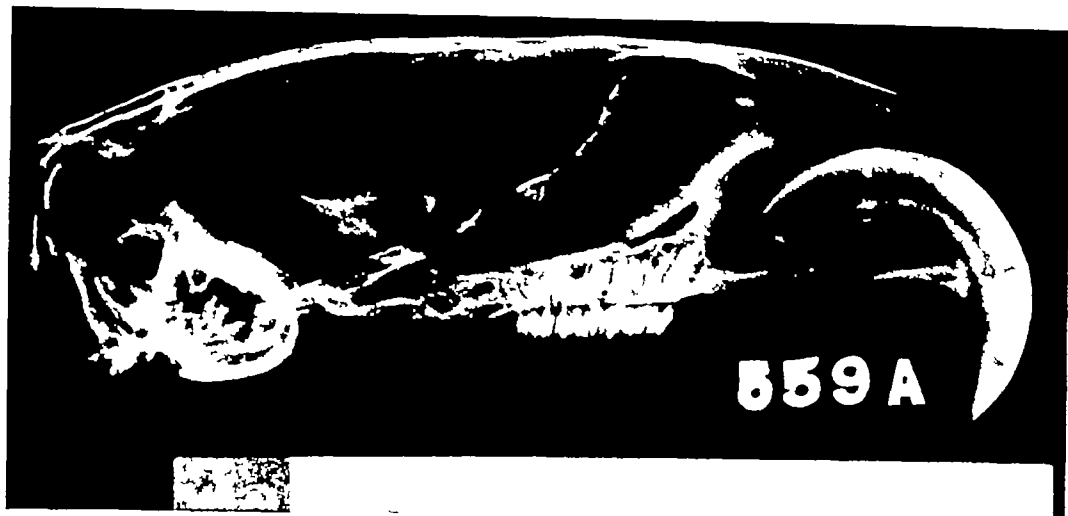


Fig. 18 Cranial sclerosis from prolonged administration of purified somatotropic hormone "Q" plus anti "Q" serum

sis of presumption of the actuality of an anterior hypophyseal parathyreotropic hormone

SUMMARY

(1) A roentgenologic study has been made of the rat cranium throughout normal growth. In growth and differentiation it is comparable to what is known to take place in man, hence conclusions derived from this work may reasonably be used to aid in understanding human cranial dysplasia.

(2) Attention is drawn to the intrinsic functional significance of the frontal sinus-homologue and the "supra-ciliary" canal in the rat, during growth and more especially in differentiation. The changes observed in this area, both after hypophysectomy and with treatment, throw light upon certain human anatomical growth variations, seen in clinical radiologic work, in man, not only in the frontal but in the other accessory sinuses as well.

(3) Complete removal of the hypophysis at an early age, in the rat, markedly retards cranial growth, especially in its differentiation. The resulting deformities form a syndrome which, although its components can be produced by other and non-specific causes, is, *in toto*, characteristic of

this loss. The resultant roentgenologic appearance has come to be, in this laboratory, in the course of two years, a reliable criterion of judgment of the completeness of hypophysectomy and the adequacy of substitution therapy. The characteristic appearances have been recognized, in the cranial skiagram, as early as the eighteenth day after operation.

(4) The defects resulting from hypophysectomy are

- (A) A marked decrease in vascularity of bone, affecting individual bones in proportion to the abundance of their normal vascular supply, and to the degree and pattern of differentiation that they normally are called upon to undergo in growth.
- (B) As a result, the processes of *pari passu* resorption and deposition are seriously disturbed, the former apparently being more affected than the latter.
- (C) All growth does not cease: cranial height and width reach materially normal dimensions, antero-posterior growth suffers.
- (D) The snout is more affected than the brain-case, growth is inadequate in all directions.

(E) A roentgenologic diagnosis of completeness of the operation can be rapidly and reliably arrived at from the following observations: the cranium is small for the age and sex of the animal, the snout is disproportionately small relative to the brain-case. The calvarial outline corresponds, *in form*, to about the age at which the animal was hypophysectomized, although the dimensions may have increased. The middle table in the calvaria is hypoplastic, and in consequence presents the appearance of being obliterated, especially in the parietal bone. The frontal sinus-homologue is hypoplastic. The characteristic tooth changes described by Schour and van Dyke are seen.

(5) Similar defects result from hypophysectomy in the dog's cranium where there is arrested growth of a true frontal sinus.

(6) Incomplete dimensional recovery from these post-operative defects has been produced experimentally by treatment with "growth" hormones. The crania of 21 hypophysectomized animals, treated with somatotrophic (purified growth) hormone, were examined. This fraction seems to have a specific effect on the vascularity of bone, restoring the normal architectural structure to the diploe, frontal sinus homologue, and cancellous bone throughout the cranium. There results, apparently, satisfactory growth and differentiation in the snout, the incisor tooth showing a normal x-ray appearance in the part grown since treatment. The beneficial effect would seem to be best marked after from 30 to 40 days' treatment, if this is instituted within a reasonable period after operation. Unfortunately, treatment beyond this point has led so far to a resistance, which Collip has suggested may be due to the formation of a specific anti-hormone. Such "Q" fractions cause a relative reduction of density in the reactivated bone which, it is suggested, may serve to aid the "expansion"

of the growing structures or, more likely, the appearance may be due to this process being active. Prolonged use of this hormone, in the hypophysectomized animal, is associated with a clear-cut decalcification and cessation of growth. It is not suggested that this defect is specific. In one hypophysectomized animal, in which the onset of resistance was delayed to almost double the normal time of onset, growth continued and the opposite effect—sclerosis—occurred.

(7) With crude alkaline growth extract, in the hypophysectomized animal, resistance was considerably longer in appearing and a greater increase in body weight occurred, but the animals were considerably more obese than those treated with "Q" fractions. Incomplete recovery occurred in the snout and teeth, while well marked overgrowth, in the anteroposterior direction, appeared in the brain-case, together with a well marked sclerosis. The impression was gained that treatment with the purified fraction produced growth that was absolutely less than with the crude extract, but that the modelling of the resultant bone was more nearly normal, and that, in general, differentiation in the snout was better. The crude alkaline extracts produced overgrown bone of a coarse, heavy, poorly differentiated type.

(8) In the intact animal, thyroidectomy and thyreotropic hormone led to demineralization recognizable in the skiagram and affecting both bone and teeth. Prolonged administration of adrenotropic hormone produced similar results in young adult rats, but there is doubt as to the specificity of this last effect.

(9) Cranial sclerosis, best seen in the calvaria, frontonasal angle and tympanic bulla, was observed in intact animals treated with prolonged parathyroid hormone dosage, and in others, similarly treated, there was evidence that simultaneous administration of a thyreotropic fraction did, to some extent, inhibit this effect, as did also purified somatotrophic hormone. In hypophysectomized animals, under such treatment, it appeared that a similar result

will follow, to a less marked degree, and that a much longer period of treatment is necessary to produce it than in the intact animal. Histologic study of animals in this group confirm the x-ray findings. The factors involved in such results are by no means clear, but it is felt that both diet and calcium-phosphorus ratio are implicated.

(10) Sclerosis was also produced by the prolonged administration of crude alkaline anterior lobe extracts. Slight in degree or lacking in the intact animal, marked sclerosis occurred in the hypophysectomized rat as resistance developed, especially as the animal became resistant to the ketogenic effect of such hormones, and this sclerosis was associated with obesity. This throws light upon the cranial sclerosis frequently to be found in obese women.

(11) One case is discussed in which sclerosis resulted from the prolonged administration of a purified somatotrophic hormone, under very special circumstances.

These investigations, of which the above is but a preliminary statement, were undertaken to throw light on the complex problems arising from the work done with Levene and Rowe prior to 1933 on human cranial dysplasia. They were made possible by the kind co-operation of Professor Collip, who has placed at my disposal for the furtherance of this study the facilities of his department. I wish to thank Professor Collip and his colleagues, Professor D L Thomson, Dr Hans Selye, Dr L I Pugsley, and Dr R L Kutz, who by their generous co-operation have made this research possible.

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SERIAL ROENTGEN EXAMINATIONS OF THE CHEST IN UNIVERSITY STUDENTS¹

RESULTS OF SINGLE FILM STUDIES IN STUDENTS WITH POSITIVE MANTOUX REACTION

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SERIAL roentgen examination of certain groups as, for instance, school children (1), young working people (2), food handlers (3), students (4), state police, soldiers, and sailors (5), have been carried out during the last few years by investigators in a number of countries

be found which cannot be detected by physical examination but can be discovered by the roentgen ray. Stimulated by the reports published, a program of roentgen serial examinations among the new students entering the University of Wisconsin was outlined and carried out,

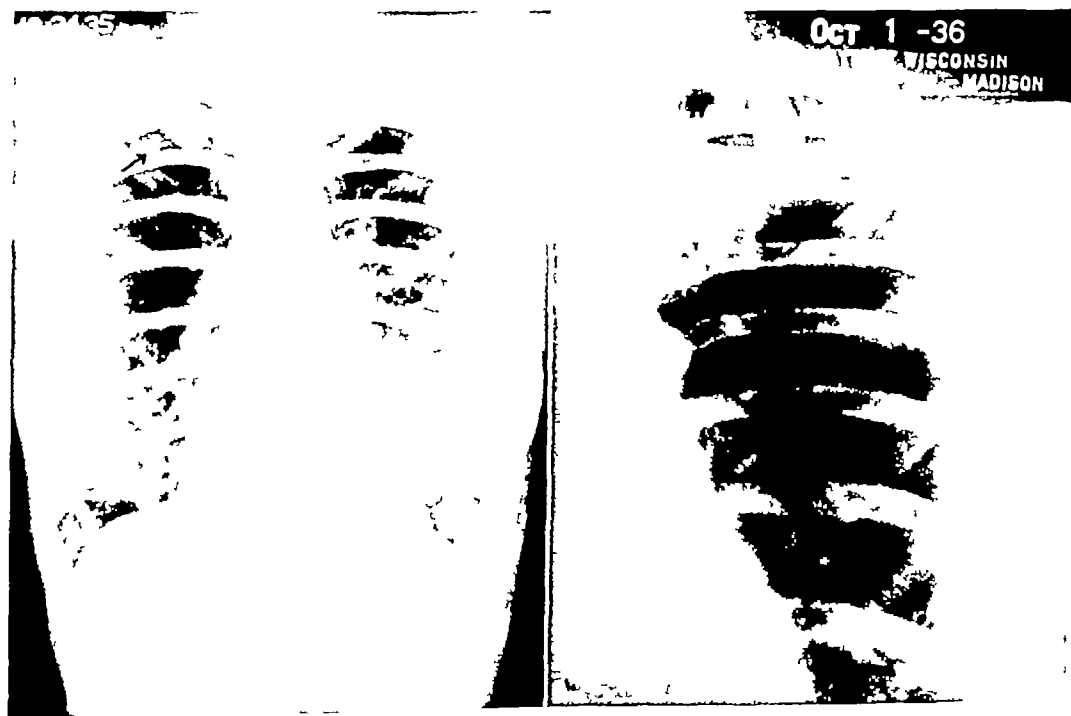


Fig 1

Fig 1 Adult type of tuberculosis in lung parenchyma

Fig 2

Fig 2 Apical pleuritis

In the United States the studies of Hetherington (6) and his co-workers are known to all interested in this subject. One of the most important results of these investigations is the fact that a small percentage of active tuberculous lesions will

we are giving in the following a brief résumé of the results

METHOD

In view of the relatively high cost of film studies the fluoroscopic method was considered first. While acceptable to some of the clinicians, the Department of Radiology opposed this way of approach

¹ Presented before the Radiological Society of North America at the Twenty second Annual Meeting at Cincinnati, Nov 30-Dec 4 1936

TABLE I

	1	2	3	4	5	6	7	8	9	10	11	12
1 Do you believe that beginning TB lesions in the lungs can be detected by fluoroscopic study as early as by good roentgenograms of the chest, either flat or stereoscopic?	No	No	No	No	Absolutely not	No	No	No	No	No	Possible in most cases	No
2 Do you believe that among those cases found negative on fluoroscopic examination there are some that would show small lesions if examined by flat or stereoscopic roentgenograms of the chest?	Yes	Yes I certainly do	Yes quite certainly	Yes	Certainly	Yes	Yes	Yes many	Yes	Yes	Yes but only small number	Yes
3 If your answer to Question 2 is in the affirmative could you give me an approximate percentage of small lesions which may be overlooked by fluoroscopic examination only?	No	No percentage sure to be appreciable	Practically all small lesions will be overlooked fluoroscopically	Depends on observer. How early lesions are not even shown by excellent films	At least 50 per cent of all	No data available	No percentage given	25 per cent	?	?	?	?
4 Does fluoroscopic examination in your opinion constitute a satisfactory and reliable method for progress studies in early cases of tuberculosis of the lungs diagnosed by roentgenogram?	No	No absolutely not	No	It does not	No	No	Yes provided film is taken frequently	No for small lesions yes for large lesions	No	I would never exclude active lesions by fluoroscopy alone	Cannot an active lesion be missed by in all cases	No This is and competent workers

Additional Remarks Appended to Some of the Questions:—There is nothing more dangerous or misleading than reliance upon a fluoroscope for diagnosis of early tuberculous lesions. It misses just the cases that are most amenable to treatment. Single films usually suffice. It is absurd to expect fluoroscopy to give the detail that one gets from a good film. Paper is not practical. A man would have to have a wonderful memory to be able to say that a faint shadow is more faint or less faint now than it was 6 months or a year ago. It depends upon the fluoroscope for the diagnosis and follow up of early TB or any phase of TB. It would be to turn back to the days before radiographs were made. No roentgenologist would do it, and any other physician who did should not be permitted to practice medicine. It is simply optically and physically impossible for the fluoroscope to detect changes of densities as accurately as can be done by the film. *A fortiori*, the fluoroscope is utterly inadequate for the supervision of tuberculous infiltrations both because it is not exact enough and because a permanent record is essential for accurate comparison of the lesion from time to time.

because we were and still are convinced of the superiority of the roentgenogram for the detection of small lesions even if single films had to be used. As will be shown later we found ourselves in full accord with leading radiologists in this country. It is true that Reid (7) advocates the fluoroscopic examination for this purpose, based on 1,035 cases with a mistaken diagnosis in only two instances, the number of detected cases of tuberculosis is not given. However, Hetherington, *et al* (8) point out a number of shortcomings of the fluoroscopic examination. It not only fails to reveal a considerable part of the calcified nodules and lymph nodes visible in roentgenograms, but rarely shows a tuberculous infiltration located at the apex of the lung above the clavicle. Schaare (9) reached similar conclusions. He compared the results of the examinations in 400 cases obtained by the fluoroscope and the roentgenogram, in 17.85 per cent the fluoroscope did not detect the lesion and in 21.75 per cent a lesion was suspected but could not be definitely classified. Licht (10), who surveyed the literature on this subject and conducted tests of his own, believes that "the explanation of the screening errors must lie in reduction of the dark vision, the reduced power of distinction, especially, playing an important part, while the reduction of the visual power plays only a minor rôle." In his opinion "the best method for lung examination is roentgenography followed by screening." In order to obtain ad-

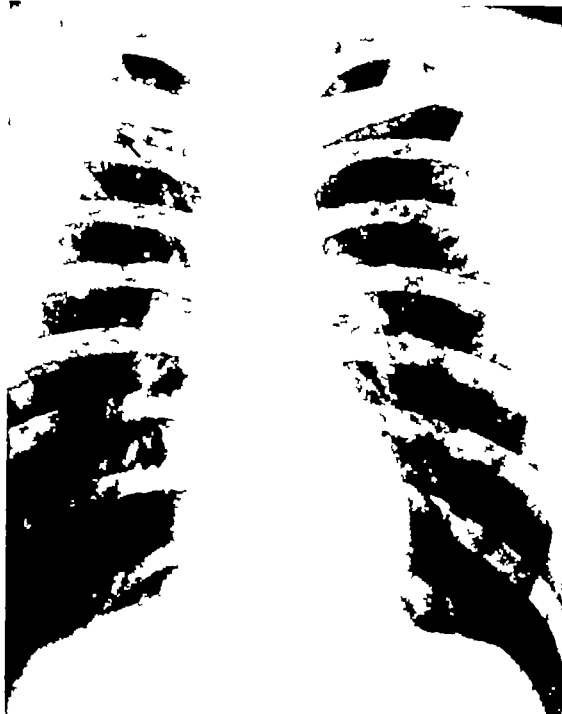


Fig 3

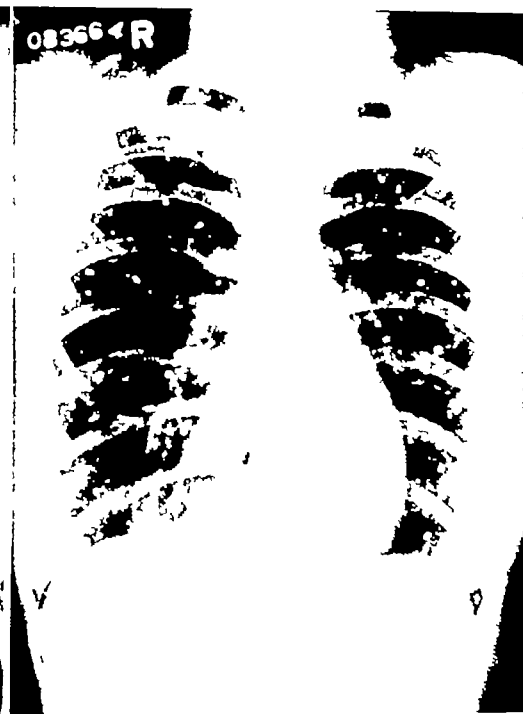


Fig 4

Fig 3 Advanced adult tuberculosis with cavitation

Fig 4 Multiple calcified hematogenous foci

ditional information we sent a questionnaire to 12 recognized radiologists selected throughout various parts of the country. The questions and answers are shown in Table I, they speak for themselves.

Supported by this overwhelming expression of opinion in favor of the film method, the necessary funds were procured to finance the single film examination. Paper films were not considered because they do not show sufficiently fine detail necessary for the recognition of minimal tuberculous lesions (see also editorial in the December, 1934, issue of *RADIOLOGY*, 21, page 591).

Since approximately from 2,000 to 2,500 new students enter the University each fall, and since the present physical plant could not handle such a number efficiently, the staff of the Student Health Service proposed to give all new students a Mantoux test and refer all positive reactors for roentgen examination. A study of the

literature seems to indicate that a positive tuberculin reaction is to be regarded as a sign of tuberculous infection either active or inactive (11 and 12).

TECHNICAL PROCEDURE

Since the examination of such a large number of individuals would add a considerable burden to a busy department, a method was worked out whereby these examinations could be done in a minimum of time and without interfering too much with the routine work.

Groups of approximately 100 students were examined at a time, the work beginning immediately after regular hours. Men and women were taken in separate groups. All clothing was removed to the waist, the women were given paper jackets to wear. The group was formed in line passing by a desk where two persons took care of the handling of records and the preparation of identification numbers. The technical procedures concerned with

the exposing of the films were handled by three persons. One technician positioned the patient before the film holder, measured the thickness of the chest, gave the necessary instructions to the patient, and instructed a second technician handling the controls as to the proper voltage to be used. A third assistant carried the cassettes to and from the dark room. By proper team work it was possible to make an examination approximately every 45 seconds and a group of 100 could be handled in about one hour. In spite of the rapidity with which the examination was done there were only 3 per cent retakes needed due to improper technic. Only one skilled technician was necessary, the rest of the work could be done by less skilled helpers. The loading and unloading of cassettes in the dark room required the services of two persons. Exposed films that could not be developed immediately were stored in light-proof boxes and processed later. The technical factors used were as follows: distance, 72 inches, 150 milliamperes, time of one-tenth second, voltage varied according to the thickness of the chest.

DISCUSSION OF THE RESULTS

The first column in Table II lists the number of cases showing no evidence of tuberculosis. The next three columns

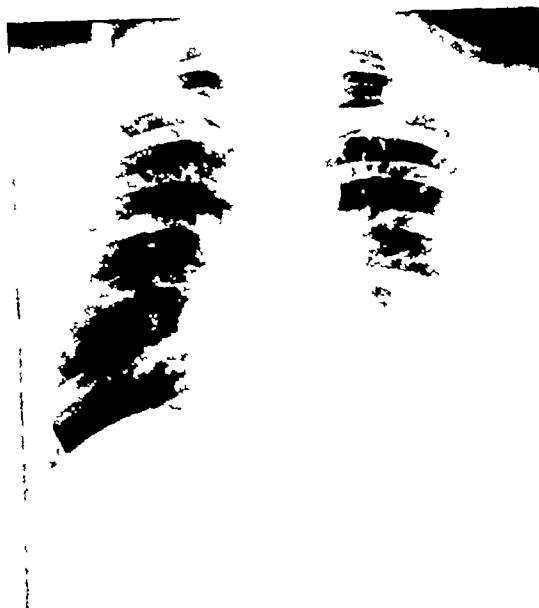


Fig 5 Metastatic carcinoma in lung parenchyma

give the number of cases showing calcification, either in the lung parenchyma (Ghon tubercle), in the hilum lymph nodes, or in both. The presence of such calcification was considered evidence of a previous first infection or childhood type of tuberculosis. The last two columns include the cases showing evidence of the reinfection or adult type of lesion. These were subdivided further into those in which the lesion was in the lung parenchyma (Fig 1) and those in which the major change appeared to be a thickening of the

TABLE II—SUMMARY OF X-RAY FINDINGS

Year	Neg	Ghon	Hilum	Ghon and Hilum	Adult Inf	Apical Pleur
1934	507	66	47	33	16	10
1935	752	93	64	51	11	2
1936	813	73	69	75	18	19
Total	2072	232	180	159	45	31
%	76.21	21			2.79	

TABLE III—X-RAY FINDINGS NOT RELATED TO TUBERCULOSIS

Year	Heart	Anom Lobes	Anom Ribs	Pleural Thick	Chron Infl	Bronchiectasis	Rib Res	Misc
1934	26	6	17	17				3
1935	48	9	18	32	5	2		2
1936	48	7	14	24	21	1	2	
Total	122	22	49	73	26	3	2	5

apical pleura—apical pleuritis (Fig 2) No attempt will be made in this discussion to classify these lesions further Suffice it to say that practically all types of tuberculous lesions were encountered, some unquestionably active and advanced as evidenced by the softness of the shadows and the presence of cavities (Fig 3), while others were more fibrotic in appearance with evidence of scarring and retraction The same is true as to the extensiveness of the involvement, the lesions varying from small round or wedge-shaped opacities to involvement of half of both lungs

On the roentgenogram, the cases classified as apical pleuritis showed a band of increased density over the summit of one or both apices In order to be of significance the lower margin of this band had to be somewhat rough and irregular and frequently fine trunk markings could be traced up to and merging with it The significance of such pleural changes may be open to question It is our opinion that when care is taken to exclude other causes for such a shadow (subclavian vessels, muscle shadows, flared rib margin), such densities are to be considered as evidence of a tuberculous pleuritis and that in this particular age group this finding has more significance than in patients of more advanced age It is often difficult to decide from a single roentgenogram whether the lesion is limited to the pleura or whether there is involvement of the immediately adjacent lung parenchyma, whether it is a recent inflammatory thickening or an older and fibrotic scar Progress films at suitable intervals seem indicated especially in many cases of this type

Two unusual cases representing accidental findings are illustrated in Figures 4 and 5 One is a student with what we consider as multiple calcified hematogenous foci, the other shows a metastatic nodule in the parenchyma from a primary carcinoma in the breast

Other roentgen findings not related to tuberculosis are listed in Table III While some of the abnormalities discovered are

of scientific interest only (anatomical variations), some have definite clinical significance, as, for instance, bronchiectasis

SUMMARY AND CONCLUSIONS

(1) During a three-year period (1934–1936) all new students entering the University of Wisconsin were subjected to a Mantoux test by the Student Health Department The positive reactors were referred to the Department of Radiology for a single roentgenogram of the chest

(2) The technical procedure is described

(3) It appeared that 2.79 per cent of the 2,719 students examined showed some adult type of tuberculous lesions, while 21 per cent presented evidence of previous first infection or childhood type of tuberculosis

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DISCUSSION

DR HENRY KENNON DUNHAM (Cincinnati, Ohio) Nothing in prevention of disease is more important than the study which has just been presented This study is to be encouraged because the death rate from tuberculosis in the adolescent has dropped very little

It is encouraging to find so many of our colleges and colleagues devoting time, brains, and money to this sane method

of stamping out tuberculosis and saving lives

The essayist brought up the relative values of the fluoroscope, the value of the paper films, the single films, and the stereoscopic films

I would like to repeat what I have said a good many times. What you men very well know but which I think you ought to repeat to the doctors in your hospitals. The fluoroscope is primarily valuable to study motion, it does not have the same value when it comes to studying structure. It is very important not to let the doctors think that they can see a great deal of fine structure with the fluoroscope.

The film records this fine structure and is a permanent record. The stereoscope gives a better record of structure and allows the roentgenologist to study the anatomical relation of that structure. The paper film records gross structure only. All of these procedures are good but to be useful they must have intelligent selection

DR JAMES JAY CLARK (Atlanta, Ga.) I am very much interested in Dr Pohle's report and wish to congratulate him on bringing this interesting subject to our attention. In Atlanta, at Emory University, we started this routine examination two years ago and, while we have not examined as large a number as Dr Pohle reports, we are increasing the group each year and expect in 1938 to have included the entire student body of the University.

At present only the students showing a positive Mantoux test have been studied by x-ray—we use the fluoroscope and follow with stereoscopic films. I should like to emphasize what Dr Dunham says, namely, that the fluoroscope is principally of value in the study of motion and in these students we obtain very little information from fluoroscopic examinations.

I am looking forward to the next four or five years in following the freshman students who have shown a positive Mantoux test and hope to determine if hilar calcification and Gohn lesions have any par-

ticular meaning. Personally, at this time I believe they mean only that the individual has had a previous tuberculous infection.

We have found a few students who had an active tuberculous infection. We have found another group which might be classed as "borderline" and these men are placed under observation and carefully watched.

There is another angle that should have consideration, that is, the effect upon the family and the student when a positive Mantoux test is reported. This test should be carefully explained to the student so that undue worry and fear may not be occasioned. I have seen several students who have had positive tests in other universities brought home to the family for examination by their own physician, who understood that the student had an active infection.

One other point—concerning the fluoroscoping of large groups of students. You will recall that during the war, many soldiers fainted when they were vaccinated against typhoid or smallpox. If you attempt to fluoroscope a group of men, place them so that, if they faint in the dark, they will not injure themselves by striking against sharp corners.

I am sure the next few years will tell us whether or not these tests are worth while. I also believe that the men who do not show a positive Mantoux test should have this same examination, as in a certain percentage of positive infections the Mantoux test is a failure.

DR WALTER S LAWRENCE (Memphis, Tenn.) If there should be any doubt in the minds of any of you as to the lack of value in the fluoroscoping of these difficult cases, these fine lesions as it were, just remember the words of Scripture. The Bible mentioned the fluoroscope long years ago. It says somewhere "A man looketh at himself in a mirror and goeth his way and straightway forgetteth what manner of man he is."

We need the permanent record!

DR ERNST A POHLE (closing) I am very glad indeed that Dr Dunham brought out in his discussion the shortcomings of our method of approach I am fully in accord with him that all students should be examined by roentgen rays and not only those who had a positive Mantoux test I do hope that eventually we will get sufficient funds and personnel to carry it

out on that basis because there is no doubt that positive cases may be overlooked now

I very strongly feel that if one were to detect only one case of active tuberculosis in all those students who are not examined roentgenologically, under our present plan the expense would be justified and well worth while

BILATERAL SPONTANEOUS IDIOPATHIC PNEUMOTHORAX IN APPARENTLY HEALTHY INDIVIDUALS¹

A REVIEW OF THE RECENT LITERATURE AND PRESENTATION OF A CASE

By FRED A. HASNEY, M.D., West Orange, N. J., and FELIX BAUM, M.D., Newark, N. J.

THE number of bilateral spontaneous idiopathic pneumothoraces published in the literature is rare, although unilateral cases have been reported in great number. In looking over the latest literature on the subject we found an extremely instructive article published by Rossel (1). Leaving aside all discussion of spontaneous pneumothoraces appearing in connection with certain diseases capable of producing destructive processes of the pleuropulmo-

healthy individual, which is also called benign idiopathic pneumothorax or simple pneumothorax, or again, but more inappropriately, pneumothorax from strain or accident."

The problem of the etiology and treatment of this condition is of real practical importance, since the pneumothorax called "des conscrits" is not as rare as one thinks, unilateral pneumothorax least of all. Of these latter, Friesdorf, in 1927, estimated

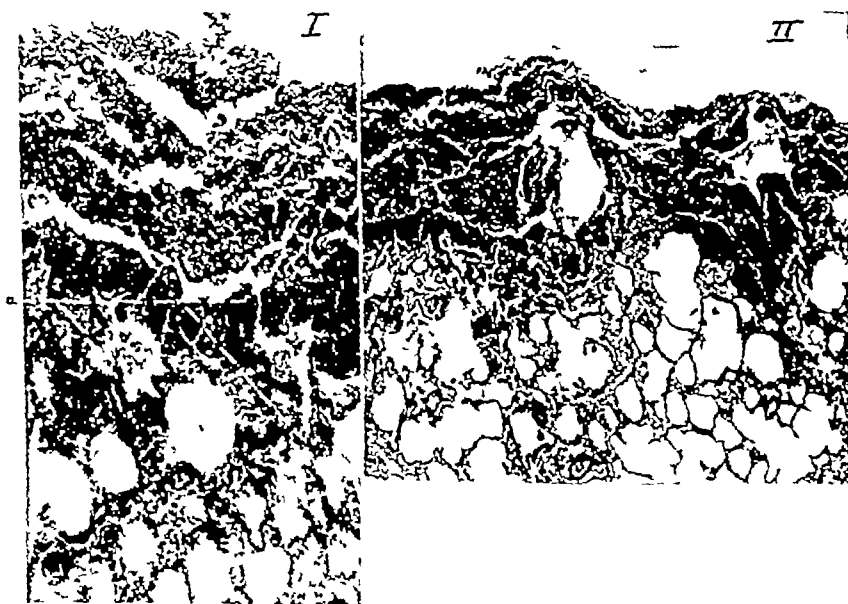


Fig 1 Air spaces within the visceral pleura. Notice connection with alveoli (a).
Fig 2 The formation of a vesicle in the beginning. (From Schmincke, Ziegler's *Beitr. z. path. Anat.*, 1928, 80, 692. Courtesy of Gustav Fischer, Jena.)

nary tissue, and pneumothoraces produced by extra- and intra-thoracic trauma, Rossel limits his attention to the "spontaneous pneumothorax which Gaillard has called "pneumothorax des conscrits," pneumothorax which occurs unexpectedly in a

that there were 177 published cases. Rossel, from his bibliographic research of ten years, concludes that at the present time this figure can be doubled. Bilateral cases, however, are infinitely more rare. Rossel found 13 cases mentioned by Olbrecht, and, in addition, one of Bedford (1929), one of Ackermann (1931), one of Sorren-

¹ X-ray Demonstration. Clinical Staff Meeting, St. Mary's Hospital, Orange, N. J., Dec. 10, 1935.

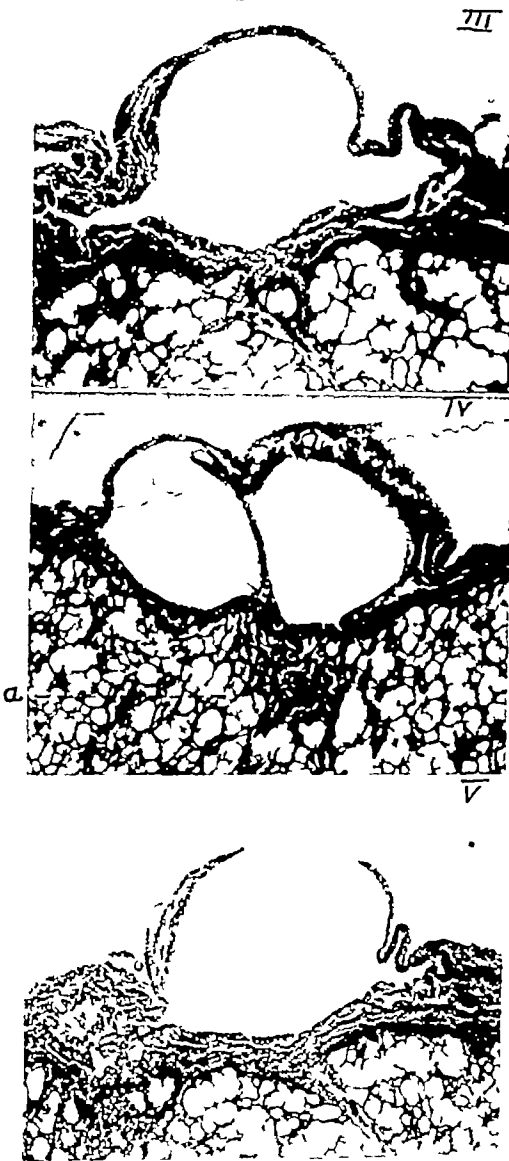


Fig 3 A vesicle fully developed

Fig 4 Two vesicles. Malformation of embryonic lung tissue (a) surrounded by normal alveolar tissue. This zone represents an incomplete or inhibited development

Fig 5 Ruptured vesicle. (From Schmincke Ziegler's Beitr z path Anat 1928 80, 692 Courtesy of Gustav Fischer Jena)

tno (1931), and, finally, one of Markson and Johnson (1934), making in all 17 cases. To these he adds two under his own personal observation. The first one was that of a boy of 17 without any past history of pulmonary disease. In apparent health,

he developed suddenly a spontaneous pneumothorax on the right without fever and without a significant pleural reaction. Rossel continued the collapse artificially. Six months later, in the course of an x-ray examination, while the pneumothorax on the right still existed, he discovered a second very complete spontaneous pneumothorax on the left with almost no pleural reaction. Subjective signs were absent. The diagnosis was possible by x-ray only. A thoracoscopy, done ten days later, did not show the place of pulmonary rupture. Instead, it revealed the presence of yellow, subpleural nodules. The pneumothoraces were absorbed progressively and the lungs re-expanded. In Rossel's other case, a young man of 20 without a previous history of pulmonary pathology, two days after his entrance in a school of recruits, developed in the morning after dressing, without preceding effort, a sudden left hemopneumothorax, with intense dyspnea. After aspiration of air and blood transfusion he improved, but five days later, in the morning again, a spontaneous pneumothorax on the other side formed suddenly. Patient died a few minutes later from asphyxia. The autopsy showed on the left a pneumothorax containing 3,500 c c of blood and a completely flattened lung. In spite of a very careful search, the pleuro-pulmonary rupture and the source of the hemorrhage could not be discovered. On cutting the lung, bronchial dilatations, localized at the apex, were found. On histologic examination, dilated subpleural alveoli were noticed. On the right side there was a complete dry pneumothorax, the lung being entirely collapsed against the spinal column. At the apex of the right upper lobe, Rossel found emphysematous subpleural bullae as big as beans. One of these was ruptured, under water, bubbles of air escaped. There was no tuberculosis on either side.

As to the pathogenesis of this condition, Rossel cites two opposing theories

- (1) That held, among others, by Sergeant, of a tuberculous origin,
- (2) That held by Gaillard who postu-

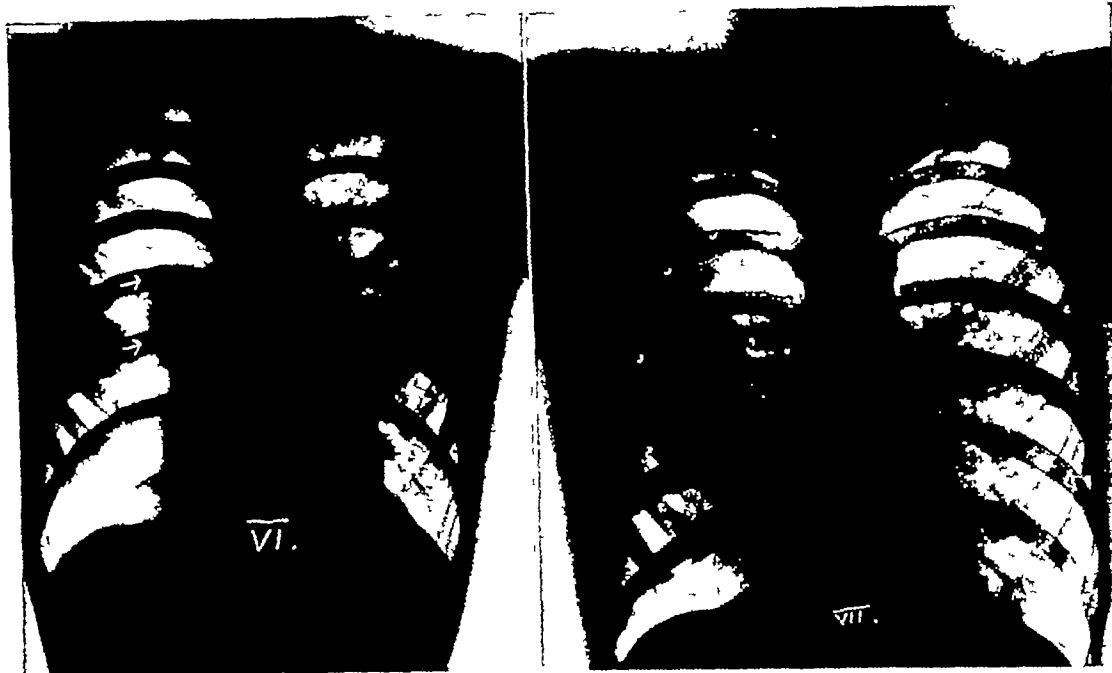


Fig 6 Massive spontaneous collapse of right lung (Oct. 17, 1934)

Fig 7 Bilateral spontaneous pneumothorax (Nov. 10, 1934) No evidence of active pulmonary tuberculosis

lates the rupture of an emphysematous vesicle, discarding all ideas of infectious origin. As objection to Sergent's theory, Rossel points out the fact that pneumothorax of the idiopathic type occurs very rarely in sanatoria, that in these cases of idiopathic spontaneous pneumothorax the pleural reaction is generally absent, or if present at all, is insignificant and fleeting, and that there is a tendency to recurrence. Rossel distinguishes two varieties of pneumothorax appearing

(a) on both sides at the same time (simultaneous),

(b) first on one side and then, after a variable period, on the opposite side (alternating).

He cites a case of the first type, that of a student who, after violent exercise, was carried suffocating from the stadium. A diagnosis could not be made without an x-ray which revealed the presence of a bilateral pneumothorax. This patient recovered rapidly after aspiration of air. To explain the bilaterality in this instance, he suggests three hypotheses

(1) A single and the same cause had ef-

fect in the same way both on the left and on the right, the rupture was double because of an identical pathologic state in the two lungs,

(2) The sudden entrance and pressure of air in the pleural cavity caused a rupture of the mediastinum, by the communication thus created, the air passed into the opposite pleural cavity,

(3) The interpleural communication was not traumatic in origin but congenital.

According to the last two possibilities, the pneumothorax would be double but the pleuropulmonary rupture single. Rossel says

"When the two pneumothoraces occur successively, their formation is evidently independent one from the other: there are two ruptures, one on each side. Is it necessary to postulate for each one a different etiology? We do not think so."

In the first of Rossel's cases, summarized above, the two pneumothoraces, separated by an interval of six months, evolved in an absolutely identical manner. The thoracoscopic examination of the left side

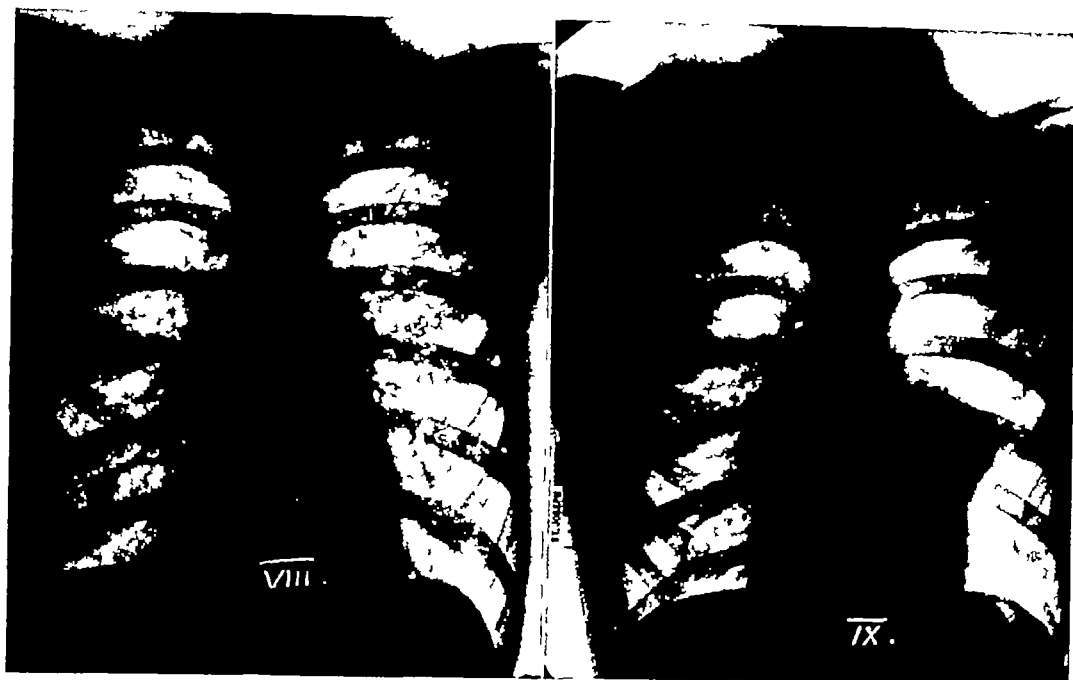


Fig 8 Complete re-expansion of both lungs (Jan 8, 1935) The annular shadows (see arrows) are probably vesicles

Fig 9 Massive spontaneous collapse of left lung (Aug 25 1935) *Arrow 2 points to an adhesion

showed the presence of some yellow, subpleural nodules, probably tuberculous in nature. None of the nodules seen, however, were perforated. The pleural linings were intact. The author does not believe, therefore, that this is sufficient evidence of a tuberculous origin of the left pneumothorax, and, by analogy, of the right. He adds

"Moreover the successive rupture of a tubercle in the two pleural cavities would constitute a very strange and hardly plausible coincidence, in view of the usual rarity of the process. It appears more logical to assume that the patient is a carrier of small bilateral tuberculous cicatrices with compensatory emphysema, cicatrices such as are present, undoubtedly, in a large number of clinically healthy individuals."

In his second case, Rossel found no trace of tuberculosis, either recent or old. The right pneumothorax was due, as the autopsy proved, to the rupture of an emphysematous bleb. The origin of the left pneumothorax remained undetermined.

The histologic examination of fragments from the apex of the lung revealed a state closely resembling the description that Hubschmann has given of certain cicatrices following minute tuberculous lesions, having given no clinical signs. The cause of the pneumothorax was probably a rupture of subpleural cicatricial emphysematous alveoli.

The problem of treatment is summed up in the question whether to continue these pneumothoraces or to leave them alone. As a rule they absorb very rapidly. Because of the recurrent character of these pneumothoraces, it is necessary, at any price, to obtain pleural adhesion. The continuation of the pneumothorax by repeated refills attains precisely this end. The introduction of air into the pleural sac alters its epithelial linings, which, when the artificial pneumothorax is abandoned, favor the adhesion of the pleural layers. Also, by irritation, this process provokes the new formation of connective tissue, leading to an important thickening of the

serosa Thus the patients are given the pleural solidity which they seem to lack Rossel believes that, in general, continuance of the artificial pneumothorax for from six to nine months is sufficient

According to Sten Grapengiesser (2), spontaneous pneumothorax in apparently healthy individuals manifests itself either by a single attack or by repeated attacks on the same side (in about 20 per cent of the cases), or, very rarely, by alternate attacks on two sides, attacks which are often so close together that they produce a bilateral pneumothorax Grapengiesser adds to the list of cases reported in the literature one case which he himself observed of alternating spontaneous pneumothorax in which the attacks, first on the right and then on the left, were separated by a period of about a month Grapengiesser believes that this condition is rare and the prognosis favorable Consequently autopsies are infrequent and anatomical research is made very difficult Kjaergaard found in four personal cases, at autopsy, that there was formed in a small bronchus a sort of valve, permitting the passage of air more easily on inspiration than on expiration Beyond this valve there appeared a "valvular vesicle" which had broken and given rise to the pneumothorax Kjaergaard thinks that all the cases of simple pneumothorax are due to the rupture of valvular vesicles Grapengiesser states

"It is extremely probable that at the appearance of the first pneumothorax, there occurs a factor which favors the production of a pneumothorax on the opposite side At the time of a sudden unilateral pneumothorax the circulation of blood in the affected lung is found to be obstructed A larger quantity of blood belonging to the lesser circulation must then suddenly make its way across the capillaries of the unaffected lung This fact, along with the concomitant dyspnea, leads to a hyperemia which one would suppose would bring about contraction of the small bronchi Pfanner has shown that a partial bronchial stenosis has a tendency to let pass more easily, like a valve, the air of inspiration than of expiration, which probably means that in the course of inspiration the negative pressure neutralizes to a certain extent the stenosis

A unilateral pneumothorax then would always bring about a hyperemia of the small bronchi of the opposite side, which would favor the production of valvular vesicles on that side The dyspnea should also lead to a rapid distention of the valvular vesicles in process of formation "

As to the mechanism of development of bilateral spontaneous pneumothorax, Grapengiesser believes that when a pneumothorax is produced on one side and more particularly if it is produced suddenly and is accompanied by intense dyspnea, there is added to the lung of the opposite side an excessive burden which favors in certain cases the production of a valvular vesicle

Castez and Mazzei (3) call the recurrent spontaneous pneumothorax "benign" They believe, as quoted in the "Journal of the American Medical Association" abstract, that the subpleural blebs form mechanically, at the level of the weaker or slightly altered areas of the lung, at the time of gaseous over-distention at that level They support this interpretation by the data given at the roentgen and anatomopathologic studies of the lung in this condition as well as by results of experiments They advise roentgenologic search for the presence of fine ring shadows at the contours of the visceral pleura which represent subpleural blebs located at that level In the roentgenograms of one of the authors' patients the shadows given by the subpleural blebs were evident in all the consecutive roentgenograms The prognosis and treatment of the condition are the same as those of non-recurrent "benign" spontaneous pneumothorax

An important contribution to the subject of bilateral spontaneous pneumothorax was made by A Schmincke (4), pathologist in Heidelberg (see Figs 1 to 5) Unfortunately, the clinical history given by Schmincke is incomplete insofar as x-ray findings were not mentioned at all Schmincke autopsied a case of a young woman who, a year before her death, had suffered from dyspnea following physical exertion The family physician had aspirated clear and sterile fluid from both pleural sacs After

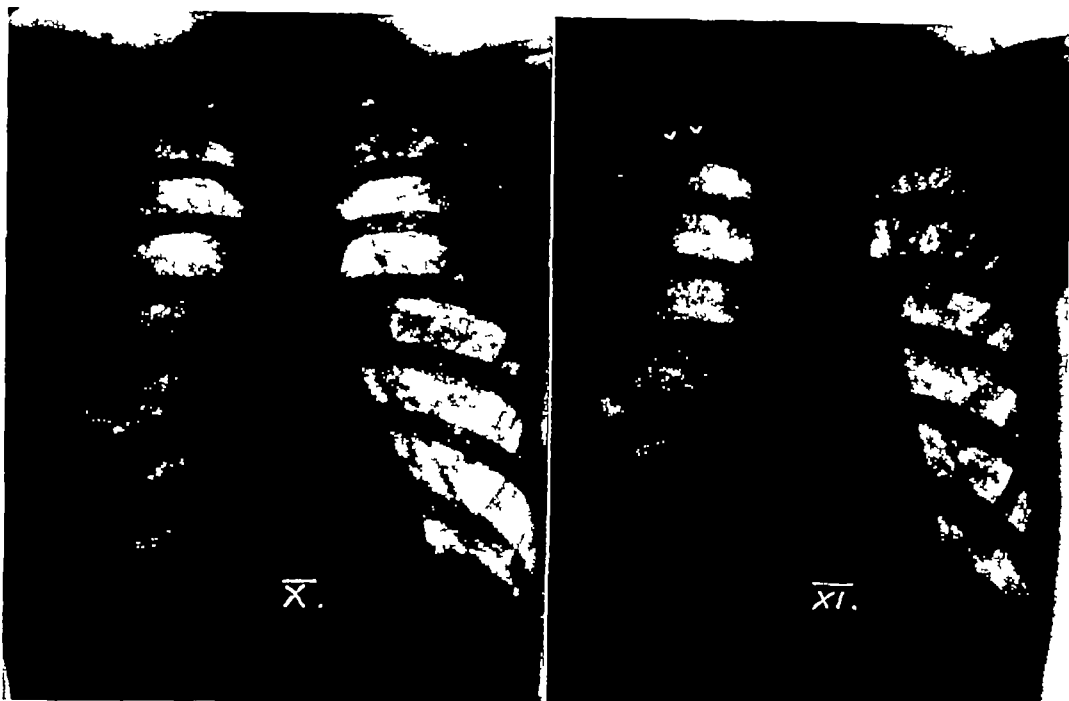


Fig 10 Left lung almost re-expanded A small amount of air is noticeable around the apex

Fig 11 Partial spontaneous pneumothorax on right, accidentally found during routine x-ray check up (Nov 23, 1935) Patient had no pleural reaction at this time

admission to a hospital, a bilateral pneumothorax with fluid formation was found. Tubercle bacilli were absent, and there was no fever. After repeated aspirations of fluid and air, the patient's condition improved, but after nine months she died of "increasing dyspnea." The interesting finding in Schmincke's autopsy report was a "compression of both lungs, especially of the left" and, macroscopically, a number of air-filled bullæ in the pleural tissue. With the aid of a magnifying glass, he could detect minute perforations of the cupola of the pleura, he was unable, however, to demonstrate air bubbles escaping through the perforations after injection of air into the bronchial tree. Microscopically, he found normal lungs and normal bronchi, and subpleural cysts connected with the alveoli of the lungs. Figure 1 shows numerous air spaces within the pleural tissue, Figure 2 the beginning of the formation of bullæ, Figures 3 and 4, large bullæ localized just under a thin pleural layer, and Figure 5 a ruptured bulla.

We were fortunate in detecting last year a similar rare case of a young man whose case record reads as follows:

Young healthy male adult, 23 years of age. Previous history negative except for occasional colds of short duration.

Oct 17, 1934, while sitting in chair, the patient stooped to pick something from the floor. He struck his right side against the chair and felt a slight pain in the middle of his right chest. When he arose and walked, he felt dizzy and short of breath, dyspnea continued and he felt faint. He was taken to the hospital and a chest roentgenogram was made. The film showed a complete pneumothorax on the right side (Fig 6).

The right chest was strapped for relief of pain. After the right side was strapped, the patient complained of pain in the left chest. He remained in bed ten days.

A roentgenogram made Nov 10, 1934, showed a bilateral pneumothorax (Fig 7). One made on Jan 8, 1935, showed both lungs to be expanded (Fig 8).

The patient led a normal life, working

daily, from January until Aug 25, 1935. On that evening he jumped over a stone wall, striking his chest lightly while jumping. The next morning about 11 45 A M he felt pain in the lower left chest, and again became dizzy and dyspneic. X-ray examination the next day showed a complete pneumothorax on the left side (Fig 9). The left chest was strapped for relief of pain and the patient remained in bed for a few days.

A roentgenogram made Sept 25, 1935, showed the left lung almost re-expanded (Fig 10). On Nov 23, 1935, the patient was again checked up roentgenologically and the film showed a partial pneumothorax on the right side (Fig 11). He had no pleural reaction, however. The clinical, roentgenologic, and laboratory findings were otherwise negative except for diseased tonsils which were removed under local anesthesia, Dec 19, 1935. He has had no cough or sputum at any time.

On Oct 28, 1936, after an interval of apparently perfect health, while sitting at the breakfast table he felt again a sudden pain in his right chest. He waited for two days before he came to us again and we found, on fluoroscopy, a new spontaneous pneumothorax on the right side. The left lung was normal. We finally decided to continue the pneumothorax artificially by weekly insufflations of about 350 c c of air, given under negative pressure, for about six to nine months, until the visceral pleura should show roentgenographically a thickening which would guarantee a complete obliteration of the right pleural sac after re-expansion. The patient is working steadily and feels comfortable.

In commenting on this case we are inclined to accept Rossel's theory of "same effect, same cause." There was not the slightest evidence of active pulmonary tuberculosis. The parahilar annular shadows seen on the film taken after bilateral re-expansion (see arrows on Fig 8) are, in our opinion, due to bullae described by Schmincke (4). The bilateral spontaneous pneumothorax of our patient was of the

alternating type. The first rupture occurred on the right side, the second one on the left before the right lung had had the opportunity to re-expand completely (Fig 7). During the third attack the left side collapsed (see Fig 9) but an adhesion (see arrow 2 in Fig 9) between the two left pleural layers, which must have formed after the re-expansion following the second attack, prevented complete compression of the left lung. The pneumothorax on the right following the third attack must have been so small and the opening of the superficial bulla so minute that the patient did not notice any discomfort. It was detected only by accident during the last x-ray check-up.

As to the treatment of our patient, we admit that bed rest and strapping of the chest alone do not guarantee against a further accidental collapse. It is safer to continue the pneumothorax, first on the right, artificially for a while until the x-ray findings show a thickened visceral pleura which, after re-expansion, will remain adherent to the parietal layer. The irritation by artificially insufflated air alone is, in our opinion, sufficient, and we would surely apply artificial pneumothorax on the left also, if another accident should happen.

We do not recommend the use of irritating substances other than filtered air intrapleurally. Sterile mineral oil or saline solution injected into the pleural sac would surely produce a stronger irritation than air, but their use would be too risky. The ideal thing in pneumothorax is to keep the pleural sac dry.

SUMMARY

A case of idiopathic spontaneous bilateral pneumothorax in an otherwise healthy young individual is presented and the recent literature on the subject is discussed.

Pulmonary tuberculosis as a causative agent could be ruled out in our case. It is assumed that the accidental collapse of both lungs is explained by the presence of

subpleural bullæ, as described by Schmincke

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giesser (2)

A RARE DEVELOPMENTAL ABNORMALITY OF THE ATLAS¹

E. W. S. LAWRENCE, M D, and WILLIAM D ANDERSON, M D, Memphis, Tennessee

THE case forming the basis of this report is that of a white female about 35 years of age whose car, waiting for a light to turn was bumped into by a street car, causing her head to jerk backward with some degree of violence

The first x-ray examination in this case was made a few days after the accident and an interpretation of the films by the attending surgeon as a fracture of the atlas, precipitated legal proceedings

Our first-sight impression on the examination of the x-ray films in this case, was that they did present a fracture of the atlas. On further and more detailed examination, however certain points presented themselves which are entirely incompatible with fracture of this bone at the points where fracture, at first sight appears to be. In this case the posterior portions of the posterior arch of the atlas are separated from the anterior portions of the bone by a space of about one-half inch in which space no bone at all appears neither the normal anterior portions of the posterior arch of the atlas nor any fragments of them. The most posterior portion of the atlas though apparently displaced backward is actually in its normal position—not displaced at all. This fact is easily demonstrated by actual measurements on the films of normal necks of the same approximate size. What has become of the bone which normally bridges these gaps of one-half inch between the right and left aspects of the posterior arch and the right and left lateral masses? It is nowhere to be seen in the films of this case.

To answer this question correctly we must recall certain facts concerning the development and ossification of the atlas. Gray's "Anatomy" records the fact that this bone develops by an *inconstant* number of centers, the variation being from two to



Fig. 1 Radiograph of the case reported. Note the total absence of the bone in the arch of the atlas on both sides between the posterior portion and the lateral masses. The relationship between the posterior tubercle of the atlas and the spinous process of the axis is normal.

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¹ Presented before the Radiological Society of North America at the Twenty-second Annual Meeting, at Cincinnati, Nov. 30-Dec. 4 1936.

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DISCUSSION

DR BYRON H JACKSON (Scranton, Pa) I think one cannot add anything to a perfect work, and, of course, I could not discuss Dr Lawrence's paper by adding anything to what he said

One thing that this paper has reminded me of and helped me with is that x-ray men should be familiar with embryology There are so many times when we need to know something about embryology and we pass it up and later on we find, if we had just had embryology and studied the development of some of these things, it would have helped us very much

Sir Arthur Keith tells us that the cervical vertebræ do not begin to develop until the third month When we remember that the body and head are connected in the embryo, that there are no arms or legs, and at the third month the neck begins to be formed and the head is pushed away from the body as the heart and the brachial plexus elongate, that probably explains the reason why the cervical vertebræ are sometimes said to be normally anomalous

Therefore, we ought to familiarize ourselves with the spine and its development so that we may know where these anomalies are likely to occur

I knew very little about the anatomy of the first cervical vertebra until I went down to the University of Pennsylvania and told them I'd give them three guesses on how much I knew I brought with me some anomalous first cervical vertebræ If you men are interested, you can see seven or eight different kinds which Dr

Batson of the Post-graduate School prepared for me

If we know where these anomalies are likely to occur, we will be looking for them and, furthermore, the ordinary examination of the spine which gives us an antero-posterior and a lateral view of the spine is not sufficient We have a patient come into our office or into the hospital where we make the regular anteroposterior and lateral views—it is my opinion that a lateral view should always be made with the patient lying on his back

Dr Lawrence said in his paper that a fractured first cervical vertebra was a dangerous thing Dr Ross Golden says the patient should always be examined by the roentgenologist and not by the technician, because the patient is apt to be killed while the examination is going on

If we familiarize ourselves with the places where these anomalies are likely to occur, we will find a lot of them in the spine that we have been passing up For instance, we will find them on the oblique views of the lumbar spine and the dorsal spine, which we rarely make

I want to also say that when you are examining a spine, do not forget that it is quite important—and Max Hubeny will agree with what I have just said for he wrote a paper about it one time—it is very important to put the patient in the prone position and to make oblique views of the spine

DR WALTER S LAWRENCE I wish to call your attention, in closing, to one of those specimens that Dr Jackson so kindly brought—the one on the right hand side just over the white placard there That simulates the one that I have reported, only in that case there is possibly one-tenth of the posterior ring of the atlas that is not ossified and in the case I reported nearly half of it is not ossified



Fig 2 Radiograph of a normal neck showing the normally ossified posterior arch and the relationship between the posterior tubercle and the spine of the axis

film It also means that any lack of ossification can be clearly demonstrated

The conclusion reached in this case is that it presents a *developmental abnormality in the form of incomplete ossification of those parts of the ring of the atlas which connect its most posterior part with its lateral masses on either side* To be more accurate, it presents a complete lack of ossification of the parts mentioned These parts of the atlas, however, are, of course, present in the form of tough semi-rigid hyaline cartilage containing no lime salts

The claim might be made that the cartilaginous parts of this atlas might be fractured, crushed, or torn from the ossified portions with which they are blended, and that such injury could not be demonstrated by the x-ray film True enough

Certainly the roentgenogram could offer no *direct* evidence against the existence of such injury It can and does, however, offer the strongest possible *indirect* evidence, or, as it were, circumstantial evidence against the existence of such fracture This evidence is to be found in the fact that there is no disturbance of the relationship normally existing between the posterior portion of the atlas and other bones of the neck One can hardly conceive of a degree of violence just sufficient to crush or tear tough cartilage and still not dislocate in any way bone with which this cartilage was intimately blended With these facts in mind we are of the opinion that neither the bone nor the cartilage intimately blended with it was injured to any appreciable degree

Nor do the clinical symptoms in this case suggest fracture Records of fractured atlas cases show that 53 per cent prove fatal and that in most cases death follows immediately Other individuals die suddenly as a result of manipulation of the broken bones A few recover

In this case both the *objective* and *subjective* symptoms following the injury were so mild that at least one surgeon passed them up as inconsequential At the time the x-ray examination was made by us, ten days following the injury, the only symptoms elicited were the *subjective* ones of stiffness of the neck and what the patient described as nervousness

We are reporting this case not only because we believe it to be extremely rare, but also because we realize that some day another accident and another incompletely ossified atlas may meet and also be followed by court proceedings This patient having been assured by her doctor that she had a broken neck, was, in spite of the mildness of her symptoms, suing for \$15,000 damages

We might add that after a copy of our report was sent to the plaintiff's lawyer the case was settled out of court for a comparatively small sum

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X-RAY DIFFRACTION STUDIES OF GLOBULAR PROTEINS

I EGG ALBUMIN

By GEORGE L. CLARK and JOHN H. SHENK, *Urbana, Illinois*
Chemistry Department, University of Illinois

INTRODUCTION

THE early workers in protein chemistry devoted practically all of their time to the problem of isolating and determining the constitution of the structural units present in different proteins. Fischer and others have shown that the amino acids are joined by the peptide linkage into long chains, but the structure of the protein molecule as a whole remained a complete mystery until the last few years when the use of x-rays in the study intact of the molecular structure of complex substances opened up a new line of attack. The study of proteins by means of x-rays is one of the most recent, because one of the most difficult, developments of structure analysis. The fibrous proteins, for the most part, yield patterns rich in information and different fibers give vastly different diffraction patterns, while the non-fibrous or globular proteins, as they are ordinarily available, give patterns which show a monotonous sameness regardless of the source, molecular weight, etc., of the protein. Only recently, by the use of moist samples, have sharp line diffraction patterns been obtained from these globular proteins.

The purposes of this investigation were as follows

- to obtain diffraction patterns of crystalline egg albumin and crystalline hemoglobins,
- to compare patterns of hemoglobins from different species for differences as noted in crystallographic studies,
- to study denaturation of proteins by chemical reagents,
- to obtain diffraction patterns of the pigment fraction of hemoglobin

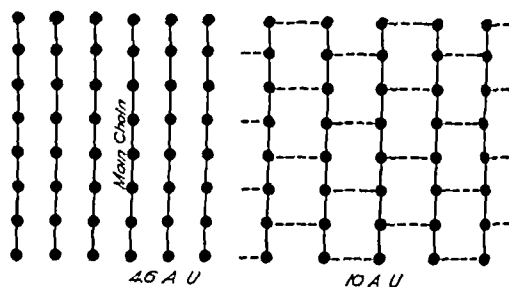


Fig 1

These investigations were undertaken because diffraction patterns had been reported for only one hemoglobin, that of rat, no patterns have been reported for hemin or egg albumin, both of which have been obtained in crystalline form many times and denaturation studies have usually been limited to heat and alcohol. The first paper in this series is concerned with egg albumin, the second with hemoglobins, and the third with the effect of formaldehyde on proteins.

THEORETICAL

The use of x-rays for examining the atomic and molecular structure of solids has opened up a new method for investigating complex materials such as the proteins. The work of Brill (1), of Katz and Gerngross (2), Meyer and Mark (3), Astbury (4), and Speakman (5) as well as many others on the x-ray examination of fibrous proteins has given us a much better understanding of the true nature of these substances in their native state. This method is much superior to the chemical method, which destroys the original structure and examines the fragments. The x-ray photographs of silk and the stretched keratins are the only protein fiber photographs about which we may be confident that the main structural features

are known, but practically nothing is known as to the precise details of the individual chains

A study of the elastic properties of hair in combination with an x-ray examination by Astbury and Street (6) led to the conclu-

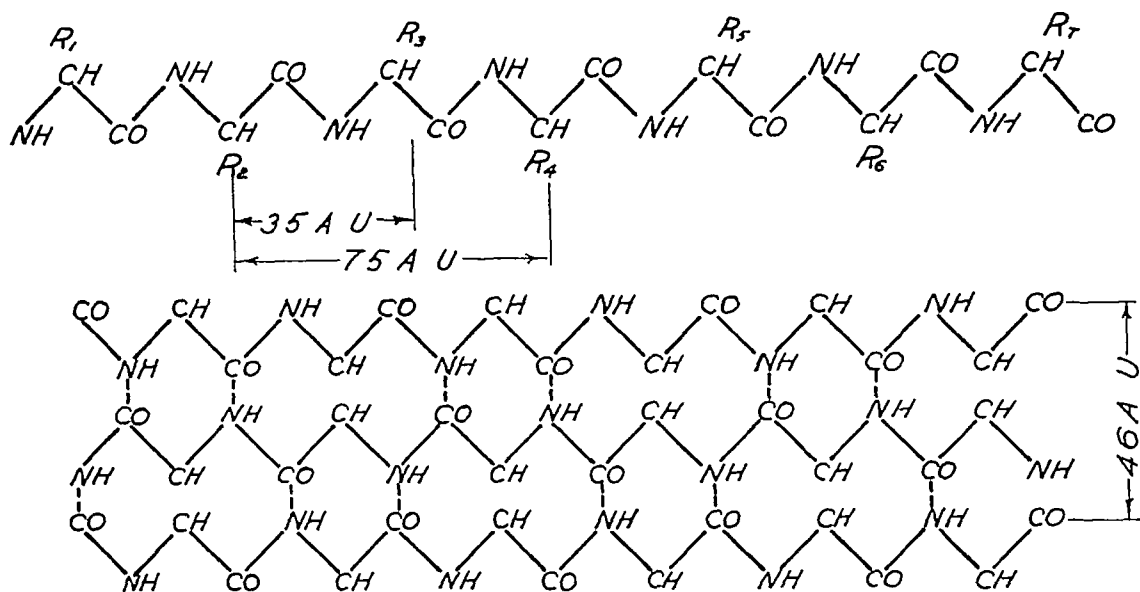


Fig 2

X-ray diffraction photographs obtained from proteins, either fibrous or globular, all show two principal spacings, 46 \AA U and 100 \AA U . A study of the fiber patterns of silk and stretched keratins leads to the conclusion that they consist of fully extended polypeptide chains which are characterized by two principal side spacings approximately at right-angles to each other, the 46 \AA U spacing arising from the effective thickness of the so-called "backbone" of the chain, and the 100 \AA U spacing from the lateral extension of the side chains standing out from the amino acid residues. These two spacings appear to represent the two principal linkages between the polypeptide chains and may be represented diagrammatically as in Figure 1. The general formula of a fully extended polypeptide chain and two associated chains, with side chains omitted, is represented in Figure 2.

These chains are supposedly held together in this direction by an attraction between the $=\text{CO}$ and $=\text{NH}$ groups of neighboring chains ("backbone linkage").

sion that hair consists of folded polypeptide chains and that when stretched the chains unfold, giving a fully extended structure as represented in Figure 2. The globular proteins give evidence of long chains but they are evidently folded and crumpled more than in hair and this would explain why the spacing corresponding to the amino acid residue does not appear in the diffraction photograph. The patterns usually obtained from non-fibrous proteins and those from disoriented fibers are nearly identical, which leads us to the belief that there are two stable and insoluble states of protein structure, the fibrous and the denatured. In the denatured state, there is a general similarity between x-ray powder patterns of proteins. The diffraction pattern in every case consists of two rings, roughly of constant dimensions, but varying somewhat in sharpness. Existing evidence suggests strongly that the inner ring is to be associated with the side chain spacing and the outer with the "backbone" spacing of polypeptide chains.

esses, another ring of spacing (about 3.6 Å U) appears, indicating a more highly organized state

Many attempts have been made during the past years to get x-ray diffraction patterns of the crystallizable proteins, but until recently, no truly crystalline diffraction photographs had been obtained. The patterns always consisted of the two rings mentioned above, even though proteins as different as edestin, egg albumin, and hemoglobin were used. In 1932 Clark and Corrigan (7) reported long spacings from insulin, using long wave length x-rays from a magnesium target. Bernal and Crowfoot (8) found that pepsin crystals rapidly lost their birefringence and crystalline appearance upon exposure to the air. By keeping a crystal moist with its mother liquor during exposure, they were able to obtain single crystal diffraction patterns and to determine the unit cell size. Since then, patterns have been obtained for crystalline urease and pepsin by Fankuchen (9), for rat hemoglobin by Wyckoff and Corey (10), and for Bence-Jones protein by Magnus-Levy, Meyer, and Lotman (11).

DENATURATION OF PROTEINS

Denaturation is a change of a kind not yet understood which the fresh crystallizable protein is capable of undergoing in the presence of water. There is no general agreement among investigators as to whether the alterations of the protein are purely physical, that is, involve only a change in the state of aggregation, or are fundamentally chemical in the sense that there occurs an internal structural rearrangement of the molecule. It is made evident by a decrease in solubility of the protein in water and dilute salt solutions although flocculation is not a necessary consequence of denaturation. The term itself is scarcely capable of adequate definition, but it is generally accepted that denaturation requires the presence of water and that the process is irreversible. The word, "denaturation,"

is used loosely to designate the change of proteins from a soluble to an insoluble form brought about by a large variety of physical and chemical agents, involving radiation by ultra-violet rays, x-rays and alpha-rays, heat, pressure, shaking, freezing, acids, alkalis, alcohol, acetone, formaldehyde, salts of heavy metals, alkaloidal reagents and enzymes. These products conform to the class of substances known as derived proteins.

Some of these processes have apparently been reversed—such as the reversal of the coagulation of egg albumin by Bancroft and Rutzler (12) and the solution of denatured globin, which was subsequently combined with a hemin derivative to produce a derived hemoglobin by Anson and Mirsky (13). However, merely the fact that a coagulated protein goes into solution or that in solution it may combine with another compound does not give definite proof that the denaturation has been reversed. Chick and Martin (14) have shown that heat coagulation consists of two distinct processes: denaturation, which involves the alteration of the protein, and flocculation. Therefore, the above examples of reversal of denaturation may be merely a reversal of flocculation. Denaturation then seems to be antecedent to and a definite step in the transition of the fresh undenatured (and crystallizable) protein molecule to the amorphous state represented by flocculation. At pH values away from the iso-electric point or near the iso-electric point if the salt concentration is of a certain value, denaturation may be effected without coagulation, according to Lepeshkin (15).

It seems that the nature of this phenomenon has been narrowed down to two processes: hydrolysis and dehydration. A few observations will be reviewed which any hypothesis should explain. In the study of heat denaturation of hemoglobin and egg albumin, Clark (16) comes to the conclusion that there is a chemical reaction with water because of the high temperature coefficient of heat denaturation, but that it takes place at any tempera-

ture Harris (17) observed that in denaturation there is a production of sulphydryl groups. Treating with acids and

and tryptophane content. The differences in the tyrosine, histidine, arginine, and tryptophane are attributed partly to

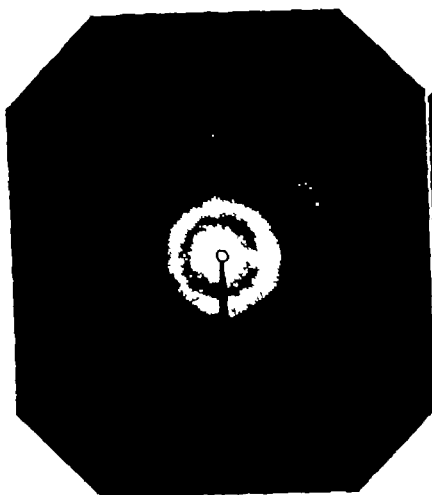


Fig 3

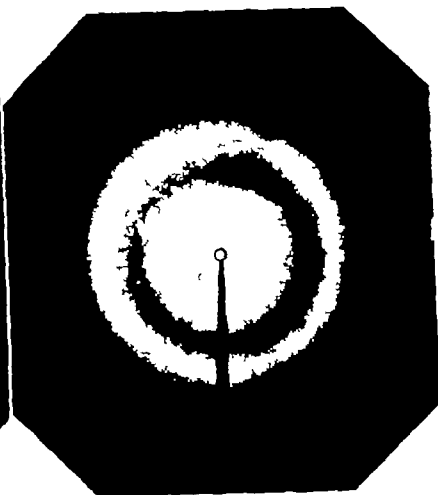


Fig 4

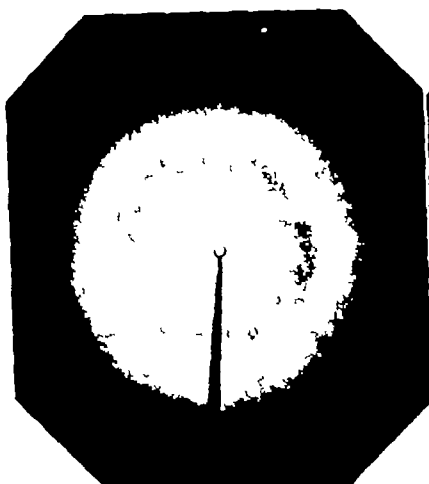


Fig 5

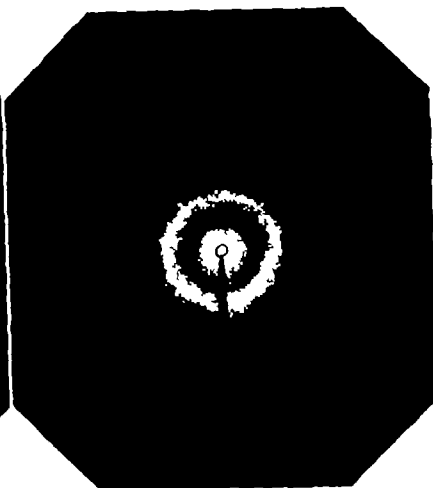


Fig 6

- Fig 3 Egg albumin air-dried
 Fig 4 Egg albumin, salt-precipitated
 Fig 5 Egg albumin, picric acid precipitated
 Fig 6 Egg albumin, trichloroacetic acid precipitated

alkalies increases the acid-and-base-binding powers of the protein, according to Wu and Yen (18). A determination of individual amino acids by Kiesel and Kuzmin (19) in edestin prepared by extraction with NaCl before and after treatment, whereby a soluble and an insoluble product were obtained, shows differences in the tyrosine, histidine, arginine,

adsorbed proteolytic enzymes and partly to intermolecular ring closures. Since there is no change in pH , Lewis (20) claims that there is no hydrolysis of a peptide linkage unless there is a simultaneous and equivalent change elsewhere in the molecule. The fact that denatured protein is more easily attacked by proteolytic enzymes in the act of digestion points to a

more penetrable and less tightly bound structure—indicating at least a partial hydrolysis

It has often been assumed that heat denaturation is due to dehydration and, therefore, the viscosity of the solution should have a lower value, but Loughlin and Lewis (21) showed that solutions of completely denatured proteins gave higher viscosities than natural ones. This apparent contradiction was overcome by Kruyt and de Yong (22), who postulated that the increase in viscosity was due to an increase in the particle size. Keyman (23) found that heat denaturation was accompanied by a volume increase, which would be expected if dehydration occurred because the water liberated possessed a larger specific volume than when oriented or compressed as a result of attraction between colloidal particles. Adding alcohol to albumin solutions first produced denaturation and then an insoluble precipitate formed, according to Lepeshkin (24). The process seemed to be reversible and very similar to the coagulation produced by salts. The addition of alcohol results in a distribution of water between the alcohol and the albumin, and hence dehydration of the albumin.

One of the most certain indications of structural alteration in a chemical compound is the change in molecular refractivity. The refractivity of egg albumin is found to increase with heat denaturation and Barker (25) interpreted this as being due to a structural rearrangement within the molecule. Several authors have discussed the possibility that denaturation results from a change of intermolecular polarization due to a change of position of some groups of the protein. Astbury and Loman (26) conclude from x-ray investigation that the polypeptide chains become more regularly arranged in the molecule during denaturation. It has also been suggested that the laying down of proteins as fibers in the animal body may be considered as a denaturation process.

EGG ALBUMIN

Historical—Egg albumin, because it is one of the most common proteins of our diet and because of the allergic reaction of many individuals to egg protein, has probably received more attention than any other protein. The earliest scientific journals contain records of research on this substance. It is one of the simple proteins yielding only alpha-amino acids upon hydrolysis. Methods for the preparation of crystalline egg albumin have long been known. One of the earliest methods is that of Hopkins and Pinkus (27), who crystallized egg albumin by acidifying with acetic acid, the solution prepared from fresh eggs by diluting with saturated ammonium sulfate solution and filtering. A slightly different method using sulfuric acid instead of acetic acid is that of Sorensen and Hoyrup (28). Early determinations gave the molecular weight of egg albumin as about 5,000, but recently McBain (29) and his co-workers determined the molecular weight to be 34,000, using diffusion through a porous membrane of constant properties as the basis of their determination. This value agrees fairly well with the ultracentrifugal method of Svedberg (30), who reported 34,500. There is no protein whose physical-chemical properties have been more thoroughly investigated than those of crystalline egg albumin and among the many investigations, that of denaturation has played a very important part.

Denaturation Studies—The solution for these studies was prepared from crystalline egg albumin obtained as will be described later. The crystals were filtered off, the excess liquid removed by suction, and then dissolved in distilled water. A measured amount of solution was evaporated to dryness, the weight of residue determined, and the remaining solution diluted to give a 1 per cent solution.

The samples were prepared by adding the precipitating reagent drop by drop to 100 ml of the egg albumin solution until

precipitation appeared complete. The precipitating solutions used were 0.1 *M* solutions of inorganic salts, 95 per cent cases some protein was left in solution. Very complete precipitation was accomplished with mercury, silver, alcohol, tri-

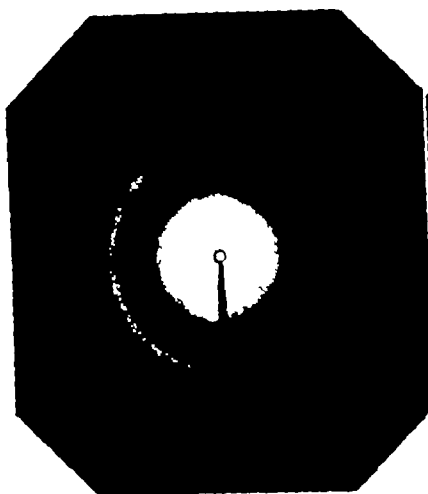


Fig 7

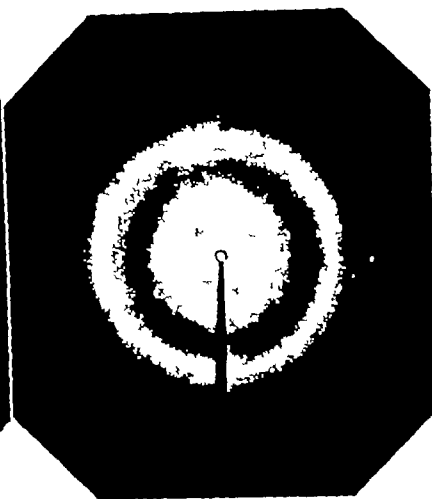


Fig 8

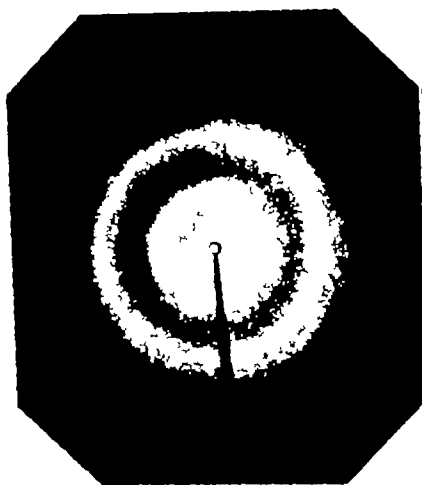


Fig 9

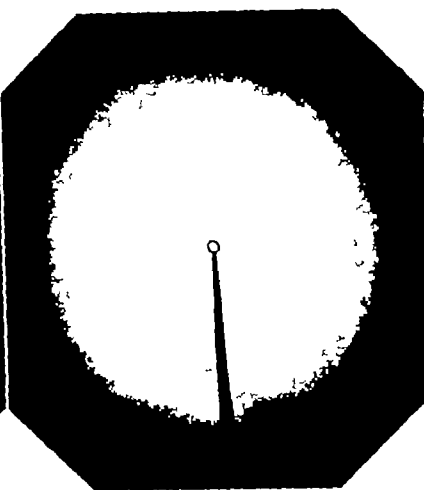


Fig 10

- Fig 7 Boiled egg white, air-dried
 Fig 8 Heat-denatured egg albumin
 Fig 9 Heat-denatured at $pH \approx 3$
 Fig 10 Egg albumin, alcohol-precipitated

alcohol, acetone, formalin, 10 per cent trichloroacetic acid, saturated picric acid and tungstic acid solution made by mixing equal volumes of $\frac{2}{3}$ *N* sulfuric acid and 10 per cent sodium tungstate. With the inorganic salts, the amounts required varied considerably, from 10 drops of ferric chloride and copper nitrate solution to 4 ml of the silver nitrate solution. In most

chloroacetic acid, picric acid and tungstic acid solutions. Precipitates were formed with salts of iron, copper, mercury, and silver. At first, Mallinckrodt's egg albumin was used, but it does not dissolve in distilled water to give a perfectly clear solution, and a precipitate was formed with salts of nickel, cobalt, manganese, chromium, and aluminum. The precipi-

tation was probably caused by a neutralization of the charge on the colloidal protein particles by the ions of the metals just named, because they gave no precipitate with the solutions of crystalline egg albumin. The precipitated protein was allowed to stand over night to allow it to settle, after which the supernatant liquid was poured off and the precipitate removed by centrifuging. To remove the remaining liquid, the moist precipitate was placed on a porous plate until it was dry enough to handle (5–15 min) and then molded into small flat pellets and allowed to finish drying in the air. These were very convenient to handle and could be held in place easily during exposure. Drying over phosphorous pentoxide seemed to have no advantage over air-drying.

All diffraction photographs were obtained by the transmission of a beam of λ -rays 0.025 inch in diameter through the sample and registering the pattern on a flat film 5 cm from the sample. The λ -rays were generated by a copper targeted Philips Metalix λ -ray diffraction tube operated at 30 kilovolts and a current of 25 milliamperes. The beam was passed through nickel foil to render it more nearly homogeneous.

The protein precipitated by the inorganic salts always contained some of the salt because when colored ions, such as those of copper and iron, were used, the dried product possessed the corresponding color. One cannot say in what manner the precipitation is brought about since it is impossible to determine by analysis whether the metallic ion is actually in combination with the protein, whether it is just adsorbed, or whether the salt changed the pH to the iso-electric point. The λ -ray diffraction photographs do not show new lines, which would indicate compound formation, but that is not conclusive evidence that there is no compound formed, since the combined atoms may be relatively far apart or randomly spaced, so that no strong interference will appear. It is also quite possible that molecular

compounds may be formed. In Table I are pH determinations of some of the solutions after precipitation.

TABLE I

Reagent Added	pH
Cupric ions	4.8
Ferric ions	4.9
Mercuric ions	5.1
Tungstic acid	4.9
Picric acid	4.2
Trichloroacetic acid	2.6

Since the pH of the iso-electric point of egg albumin is 4.6, it appears from the above table that in some cases the precipitation is due to adjustment of the pH , but this is not always true, because silver ions will precipitate egg albumin from a solution with a $pH = 1$. The silver precipitation must be carried out in very diffuse light or the precipitate becomes black. In very diffuse light, the precipitate, when dry, is a very light tan color. There, probably, is compound formation between proteins and silver ions, trichloroacetic acid, tungstic acid and picric acid. The denaturation of egg albumin by dilute salt solution can hardly be attributed to hydrolysis or dehydration because the treatment was very mild and the solution was very dilute with respect to the precipitating agent.

The x-ray diffraction photographs of salt-precipitated egg albumin resembles that of air-dried egg albumin very closely (compare Figures 3 and 4). Figure 4 is representative of the pattern obtained from egg albumin precipitated by metals. In both cases there are two rings, neither of which is very sharp, the outer ring of spacing (about 4.6 Å U) representing the "backbone" spacing, and the inner ring (about 10 Å U) representing the side chain spacing. The outer rings in both cases are broad and diffuse, showing that there has been very little change in the protein when denatured by precipitating in very dilute solutions of metallic salts.

Precipitation with picric acid likewise causes little change in the λ -ray pattern.

as shown in Figure 5. The outer ring is broad in this case also, with very little change in the inner ring. When trichloroacetic acid is used, the interferences are decidedly sharper, especially the outer ring, as was also noted by Astbury and Lomax (26) in the denaturation of proteins by heating. The reaction is probably between the acids and the basic groups of the protein molecule, or there may be a molecular compound formed. It would be expected in the latter case that the outer ring would remain quite broad, but trichloroacetic acid tends to orient the molecules and, therefore, gives a much sharper interference.

In heat denaturation, there is supposed to be a partial hydrolysis. This would produce more polar groups, which ordinarily would make the molecule more soluble. Since the substance becomes more insoluble, it would seem logical to assume that there is probably a reaction between groups already free, to form a higher molecular weight polymer which is less soluble. Heat produces an increased regularity in the structure of the denatured protein in egg white, as shown in Figure 7. The two rings ordinarily found are fairly sharp, especially the outer one, and there is a very faint ring appearing farther out at about 3.6 \AA , which may be due to the amino acid residue length. Heat precipitation from a solution of crystalline egg albumin gave a similar pattern (Fig. 8). When denaturation by heat is carried out at $\text{pH} = 3$, no precipitation takes place, but it may be coagulated by adding 0.1 normal potassium hydroxide slowly. The precipitate treated as above gives the pattern shown in Figure 9, in which the 3.6 \AA spacing is stronger than in the patterns obtained by denaturation at pH near the neutral point.

If the protein is denatured by the addition of alcohol, which is probably due to a distribution of water between the alcohol and the albumin or a dehydration process, there is a more regular aggregation than in untreated egg albumin (see Fig. 10). The same was found to be true in the pre-

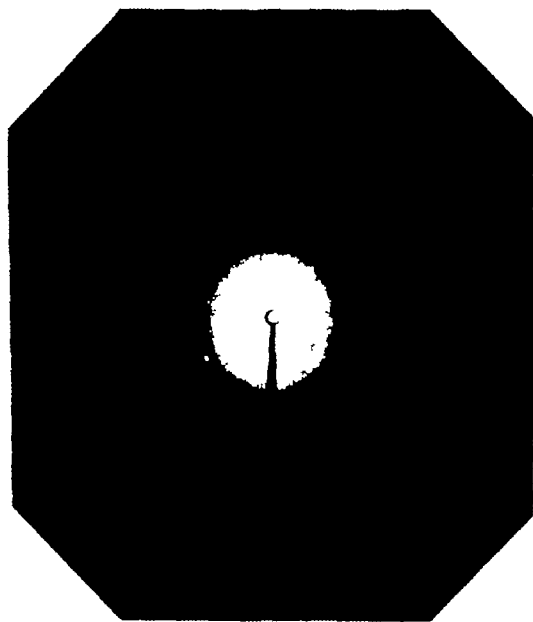


Fig. 11 Egg albumin, tungstic acid-precipitated

cipitation of egg albumin with acetone and formalin, the outer ring being fairly sharp. Although, the outer ring can be greatly sharpened, the width of the inner ring changed very little regardless of the denaturation process. This is to be expected since the chains are held together by chemical bonds laterally and only by coordinate linkage between the grids. Therefore, an entering group or molecule would tend to push the chains out of shape in this direction, producing a broad outer ring.

The product obtained by precipitating with tungstic acid is highly absorbent to x-rays and a very long exposure is required to obtain a visible pattern. The two protein rings appear faintly in Figure 11 with intense fogging near the central spot, which is probably due to large colloidal aggregates.

Crystalline Egg Albumin—The crystalline egg albumin used in this investigation was prepared according to the method of Sorensen and Hoyrup (28), who used the essential features of the method of Hopkins and Pinkus (27). The whites of 24 eggs (about 700 ml) were stirred briskly together with an equal bulk of a saturated

solution of ammonium sulfate and the precipitate filtered off. To this clear filtrate, saturated ammonium sulfate was

as above. The crystals are quite stable at room temperature if they are kept moist with their mother liquor.

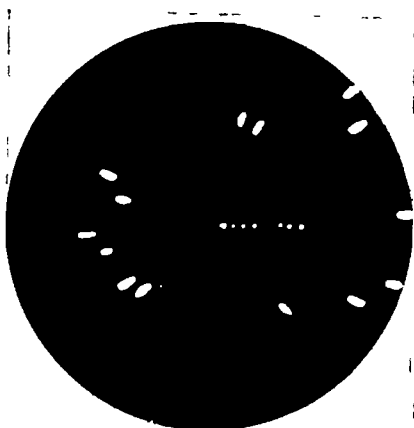


Fig 12



Fig 13

Fig 12 Crystalline egg albumin

Fig 13 Photomicrograph of crystalline egg albumin

added until incipient turbidity was reached (about 35 ml) and again filtered. N/5 sulfuric acid was added to 100 ml of this solution until a voluminous, amorphous precipitate was formed, which, at first, dissolved by stirring, but later became more difficult to dissolve and finally remained turbid. The quantity of acid to be added to the whole filtrate was calculated and added with mechanical stirring. This gives a favorable pH for crystallization. Several drops of toluene were added to prevent putrefaction and the solution was set aside for two days for crystallization, although a heavy precipitate had formed in six hours. The crystals may be filtered by suction but are more difficult to dissolve than if filtered otherwise. The composition of the wash solution is determined by preparing a series of test tubes, each containing 10 ml of the filtrate. The most concentrated solution which will not give a precipitate is used as the wash solution. This preparation was quite soluble in water, giving a clear, colorless solution and may be recrystallized by dissolving in water, adding saturated ammonium sulfate solution until the precipitate which is formed will just dissolve by stirring, and then proceeding

Since the crystalline structure is destroyed upon drying, it is necessary to keep the sample moist during exposure. The mother liquor was removed until the crystal mass was of the consistency of thick paste, after which this material was forced into a hole in a brass strip and covered with thin sheets of mica. Mica was used because it gave only spots which did not interfere with the rings given by crystalline egg albumin. To reduce background fogging so that the rings might be detected more easily, the film and sample were placed in a vacuum camera. The x-ray beam was passed through a pinhole 0.01 inch in diameter and the film-to-specimen distance was 10 centimeters.

Figure 12 shows that the egg albumin was definitely crystalline because several sharp rings appear. The interplanar spacings together with their relative intensities are given in Table II.

Some of the rings did not reproduce well, so the positions of all rings are indicated by the ink spots in a straight line. The large spots are due to the mica windows used to keep the sample moist during exposure. Figure 13 is a photomicrograph of egg albumin crystals and shows their definitely crystalline shape. The

TABLE II

Ring No	Spacing in Å U	Intensity
1	57 0	
2	39 0	vw
3	28 1	
4	21 3	
5	11 9	Beta of No 6
6	11 8	
7	10 2	Second order of No 4

crystals are very brittle, so that care had to be exercised in placing a cover glass over them to prevent loss of water while taking a photomicrograph. Upon drying in air, these crystals lose their shape and the diffraction pattern consists of only two rings, neither of which is strong enough to be seen in the crystal pattern.

SUMMARY

1 Air-dried precipitates formed by the addition of dilute salt solutions and picric acid to an egg albumin solution give x-ray diffractions similar to that of air-dried egg albumin.

2 Egg albumin precipitated by trichloroacetic acid, alcohol, and heat give essentially the same patterns but the two rings are much sharper, especially the outer one.

3 When egg albumin is denatured by heat at pH = 3 and then precipitated, the rings are quite sharp and another ring appears faintly in the diffraction pattern.

4 Crystalline egg albumin was prepared. A photomicrograph and a diffraction

pattern are shown, both of which prove its crystallinity.

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IDIOSYNCRASY, HYPERSENSITIVENESS, AND DOSE INTOLERANCE¹

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THIS paper is not intended to be, nor is it in any sense, a discussion of these conditions *per se*, but it is presented at this time as an argument that these conditions do exist as true clinical entities and to emphasize the importance of remembering their existence, so as the better to be prepared when their occurrence results in clinical and legal complications

The question of idiosyncrasy, hypersensitiveness, or normal dose intolerance is frequently an important element in the defense of malpractice litigation, brought because of alleged injuries produced by the roentgen rays. This has been particularly true of some of the more recent suits brought to the writer's notice

For medico-legal purposes, it is considered best that we discuss and handle idiosyncrasy, hypersensitiveness, and variations of dose tolerance or tissue tolerance as one subject. The writer, therefore, combines these under the same title heading, and again calls the attention of radiologists to the necessity of recognizing these conditions and keeping them in mind, in their daily handling of patients as well as in the defense of malpractice lawsuits. I say *again*, because I have several times called your attention to this same subject—before the Section on Radiology of the American Medical Association and in our Journal, RADIOLOGY

It is safe to say that there are no dosage formulæ which can be expressed or expounded so as to apply absolutely to all patients or even to any considerable number or group of individuals, without provision for, or consideration of, individual peculiarities of toleration of the normal amount of the remedial agent intended or expected to be used. Dosage of drugs, medicaments, or remedies cannot be set

at one categorical figure because no two individuals react identically, and we can have no *a priori* knowledge of what the exact effect of any stimulant, depressant, or other medicament may be. True, we know what the average effect should be, or what the effect of certain dosage on an average individual might be expected to be, but it is not the average effect nor the average individual that produces the unusual or the unexpected result, and both directly and indirectly cause our trouble

Those of us who have been in general practice have seen patients who develop a violent and severe coryza after taking small doses of K I. I had one such, who developed a "running nose" after taking two grains three times a day, but who could and did take 30 grains twice a day for a considerable time without any ill effect. Likewise, we have seen itching, erythema, and delirium produced by moderate dosage of belladonna, and deafness and blindness following the administration of three grains of quinine sulphate

Now, with all of these various and numerous manifestations of idiosyncrasy, hypersensitiveness and/or variations in dosage toleration, is it at all remarkable or surprising that some persons show unusual reactions to the roentgen rays? Would it not be far more surprising if we did not ever have patients show unusual reactions?

Reasoning from the known and acknowledged effect on patients of nearly everything used in medicine, from aatharal to zymotoid, we have a right to expect and to believe that there might be some unusual or unexpected reactions or effects from the roentgen rays. And just as it is with all other things in medicine in this regard, we have no means of determining what, if any, variation or departure from the normal and usual effect or reaction may be, or in whom to expect it

The earliest workers with the roentgen rays discovered this, and wrote about it

¹ Presented before the Radiological Society of North America at the Twenty first Annual Meeting in Detroit Dec 2-6 1935

Freund² said "It is of greatest importance to bear in mind that the tissues of different individuals do not possess the same sensitiveness to x-rays. Many authors deny this, though it would appear that even they have met with differences in the mode of reaction of different persons."

Pusey³ said "According to general opinion there is a difference in the ways in which tissues of different individuals react to the influence of x-rays. The only radical exception to this opinion that I know of is that of Kienbock⁴ who takes the position that we are not justified in assuming an idiosyncrasy to x-rays." He goes on further and states "A fact of the greatest importance, from a therapeutic standpoint, is the knowledge that individuals in good health react in precisely a similar manner to x-ray radiance." In my judgment there is no evidence to justify such a statement. The very fact that x-ray burns are comparatively so few, demonstrates in the largest and most convincing way the inaccuracy of such a position. It is literally true that at the present time (Pusey wrote this in 1904), millions of x-ray exposures have been made, and most cases of burn of a severe character come to light, yet Codman, in considering the subject of x-ray injuries, is able to find recorded in all the literature only 170 burns. Gilchrist⁵ in reviewing the literature in February, 1897, was able to collect only 23 cases, and Stone Scott,⁶ in reviewing the subject in May, 1897, was able to find only 69 cases. With the thousands of x-ray exposures that have been made, is it to be supposed that only 170 cases have been exposed beyond the point of safety? Or even assuming that only one in ten cases of severe burn has come to light, is it to be supposed that only

1,700 cases of over-exposure have taken place? Probably in one month, three or four months after Rontgen's discovery was announced, over 1,700 cases were exposed in a way that we now know to be dangerous. Many cases of burn have unquestionably been caused by dangerous exposures, on the other hand, it is certainly true that thousands of what are dangerous exposures for some individuals have been made without injury. The fact that in innumerable cases individuals have escaped x-ray effects, while in a few cases under similar conditions injuries have occurred, can be accounted for only by the existence in a few individuals of certain factors rendering them more susceptible to x-ray influence. Such a statement as Kienbock's, founded as it is upon personal opinion regardless of recorded facts, needs to be challenged. It is most mischievous in the influence which it may have upon technic, there are enough x-ray injuries due to faulty technic without throwing out so well-established a fact as personal idiosyncrasy to account for some of them.

Kienbock states

"In the therapeutic use of x-rays when one has occasion to give exposures daily or very frequently over a long period of time, the opportunity to observe personal idiosyncrasy is excellent. It has been my experience to see variations in the susceptibility to the tissues of different individuals to the influence of the x-rays. One patient will develop x-ray irritation after repeated exposures during two weeks. Another patient, under conditions of technic which are as nearly identical as care can make them, will not develop a similar irritation until two months have passed. He may then develop a reaction which is no greater, which runs no longer course, and which differs in no essential particular in degree or character from the reaction of the other individual, which was set up at the end of two weeks of similar exposure.

"It may be said, I believe, that a moderate variation in the susceptibility of individuals is constantly found, but that this difference rarely amounts to more than four times as great susceptibility in one individual as in another. In extremely rare instances this susceptibility amounts to a marked idiosyncrasy, but this idiosyncrasy is rare. On the basis of Codman's statistics, for example, it

² Elements of General Radiotherapy Leopold Freund (Vienna) translated by G. H. Lancashire. Published by Rebman London, 1904 p. 247.

³ The Roentgen Rays in Therapeutics and Diagnosis William Allen Pusey and Eugene Caldwell. Published by W. B. Saunders Co., Philadelphia 1904, 2nd ed. pp. 244-246.

⁴ Wien Klin Wchnschr. 1900 13, 1153, and Wien Klin Presse 1901.

⁵ Johns Hopkins Hosp. Bull. 1897, 8, 17.

⁶ Trans. Ohio St. Med. Soc. 1897 52, 139.

occurs less frequently than once in ten thousand individuals. This fact of idiosyncrasy must be taken into consideration in the application of the agent. It is the one fact whose avoidance requires the most care in the application of x-rays to therapeutic purposes."

Personal communications and statements of this well-known and highly credited dermatologist indicate that he has not receded from his position nor changed his opinion regarding this subject, in the 32 or more years since the foregoing was written.

A. E. Walter, in a little-known and seldom-seen useful little handbook,⁷ published in 1906, said "Some authors think that they have observed marked susceptibility on the part of certain patients, and no doubt a certain amount of idiosyncrasy must exist."

I will quote verbatim from page 96 of "The Use of the Roentgen Ray by the Medical Department of the United States Army in the War with Spain," by Captain and Assistant Surgeon W. C. Borden, published at the Government Printing Office in 1900:

"Personal idiosyncrasy and low vitality has always to be taken into account. The first, fortunately, is very rare, but as it cannot be determined beforehand, the same should always be considered. A person in ill health or debilitated is undoubtedly more likely to be burned by the roentgen rays than is one who is strong and vigorous. The well-known fact that weakened tissues easily yield to disturbing forces, holds with the action of the roentgen rays as with other factors, the action of which, if too long continued, devitalizes the cells."

Is it not remarkable that these last early observations should be made by one who was handling and studying only the most rugged and vigorous young men—soldiers in the army? While we might suppose that idiosyncrasies would be less frequent among these patients than among those in our daily practice in civil life, perhaps that argument is not so tenable as we at first thought it might be.

That much from a very few of the early observers, the more recent users and writers make it more nearly certain that we have to contend with idiosyncrasy and unstable or irregular tolerance of normal dosage.

MacKee,⁸ in summing up a very comprehensive thirteen-page discussion of idiosyncrasy, said:

"1 Variations in cutaneous susceptibility to x-rays and radium and due to known causes are of daily occurrence. These variations may be well marked. They cannot be regarded as true idiosyncrasy.

"2 Slight variations in susceptibility of unknown and undiscoverable cause are not common, and may be considered as mild examples of true idiosyncrasy.

"3 The existence of true idiosyncrasy of severe type is admitted, but it is rarely encountered.

"4 Individual peculiarities, relative to pigmentation, defluvium, telangiectasis, atrophy, etc., are common and can probably be regarded as examples of idiosyncrasy."

Hirsch⁹ said:

"In general, it may be stated that the skin reaction is, within narrow limits, the same in different individuals with the same radiation dosage. However, unusually severe reactions in some individuals have been reported.

"That there exists a hypersensitivity and hyposensitivity to the radiation as a deviation from the standard of sensitivity of the particular tissue is beyond doubt. This is an abnormal reaction and cannot be foretold."

While discussing a paper by Dr. MacKee and Dr. Morse¹⁰ before the Section on Radiology of the American Medical Association in 1927, Dr. George E. Pfahler—recognized as one of our safest and best-informed radiotherapists—said:

"If one obtains the standard of the dose by treating a small area of the skin, a very much larger dose will be obtained over a larger area."

⁷ X-rays and Radium in the Treatment of Diseases of the Skin. George M. MacKee. Published by Lea & Febiger, Philadelphia, 1907. 2nd ed. pp. 368-381.

⁸ Principles and Practice of Roentgen Therapy. I. Seth Hirsch. p. 308. American X-ray Publishing House, New York, 1925.

¹⁰ The Present Status of Cutaneous Roentgen Ray Therapy. Transactions of the Section on Radiology. A. M. A. 78th Annual Session, p. 82. Washington, 1927.

⁷ X-rays in General Practice. A. E. Walter. p. 58. Lane, London. Published by John Lane Co., New York, 1906.

and tremendous damage may be done. Keep that in mind. There is considerable variation in the skin of individuals. Therefore, if one uses a test upon oneself or one's friend and takes that as a standard, it may be of little value, and it will have much less value if taken on a dog or animal. It is questionable whether one can transfer that dosage directly to some stranger. There is about a 25 per cent variation of safety in treating cases at any time, and that 25 per cent of leeway keeps us out of lots of trouble. It helps, therefore, to use a dose that is not absolutely exact. There is a tremendous variation in the amount of radiation that different individuals can stand, and that is not surprising. If one can find 100 per cent variation in a litter of mice of the same age and that comes through the same stock, there should be a tremendous variation in a group of individuals such as are here present, who have all kinds of variations in ages and conditions. When anything happens to a patient, it is not always due to faulty technic."¹¹

The writer followed Dr Pfahler in the discussion of the same paper, and having been considering from the medico-legal aspect what the essayist had stated, I said "It is difficult for anyone not familiar with the exact conditions found, to draw the line separating idiosyncrasy and dose intolerance. Quite a number of malpractice suits have been won on the basis of the existence of idiosyncrasy, so that when we begin to discuss the dividing line between idiosyncrasy and intolerance to regular dosage, we must be careful to express ourselves so as not to be misunderstood or misquoted. The celebrated Texas case of *Hamilton vs Harris* went to the State Supreme Court twice on this very question, and other State supreme courts have had this subject under consideration and have made idiosyncrasy a most weighty matter in their decisions. Lawyers have learned that idiosyncrasy plays an important part in determining whether an overdose of radiation or any other therapeutic agent has been administered, and I am sure that a large majority of the trained radiologists in this country and throughout the world firmly believe that this condition does exist, and that there is no way by which we

can foretell whether it does or does not exist in any given individual."

Dr MacKee, in closing the discussion, said in part

"Idiosyncrasy is inherent and constant and parallels longevity. Variations in tolerance may be due to many causes, and they are likely to fluctuate. There is no irrefutable proof that true idiosyncrasy to the roentgen rays exists, although there is some evidence in favor of mild degrees of idiosyncrasy. Rather marked examples of tolerance variations are common."

The writer has seen idiosyncrasy and hypersensitiveness to the average dosage of the roentgen rays, as well as to numerous and various other remedial agents during the last 39 years, just as have all the other users of medicine in every branch and specialty. We have all seen these phenomena, and we must not forget about them.

Beside the foregoing, idiosyncrasy, variable tissue tolerance, and hypersensitiveness to roentgen radiation has been mentioned, described, discussed, and commented upon by Codman, E. E. King, Williams, Gilchrist, Scott, Scherer, Rollins, Baetger, Manges, Johnston, Witherbee, Hickey, Hazen, Pancoast, Brown, Boggs, Jaches, Remer, Skinner, Barthelmy, Wolbach, Donaldson, and numerous others in this country, and by Kienböck, Scholz, Arcelin, Lancashire, Jutassy, Benedikt, Holm, Albers-Schonberg, Schiff, Ehrmann, Holzknacht, Bergmann, Oudin, Muhlman, Peterson, Sippel, Hellmann, Regaud, Thedring, Perthes, Wetterer, Hall-Edwards, Lacassagne, Wintz, Colwell, Seitz, Holfelder, Apostoli, Knox, and many others in Europe.

Age toleration of radiation is recognized by all who have had much experience in roentgen therapy. Some sixteen years ago, Holfelder presented a table showing the percentage of skin tolerance of individuals from two months to over eighty years of age. This table is worthy of study and consideration and is here given for that purpose.

¹¹ Can you not close your eyes and see the earnest white-haired Pfahler saying that? I can.

Infants 2 to 3 months	20-25%
Infants 4 to 6 months	25-30%
Infants 7 to 12 months	30-35%

Children in second year	35-45%
Children in third year	50-60%
Children fourth to seventh year	60-70%
Children 7 to 10 years	70-80%
Children 10 to 16 years	80-100%
Persons 17 to 60 years	100%
Persons 60 to 70 years	110%
Persons 70 to 80 years	120%
Persons over 80 years	130%

With all this evidence, from the numerous sources, it behooves us to be just a little more careful and particular in the handling of our patients, in both diagnostic and therapeutic procedures

This additional care will help in more than one way to prevent trouble, because, when we become habituated to exercising greater care in this, the exercise of greater care will become routine with us, and we will be the better physicians for it

The principal purpose of this presentation is to call it to the attention of some radiologists who might become a little lax in their dosage, for the moment forgetting about idiosyncrasy and the variations in dose toleration, and give just enough overdosage to cause trouble

Malpractice suits are much easier to defeat or to win if they are not started, and if we keep ever before us the realization

that some individuals do not tolerate as much as others, not only of sodium salicylate, belladonna, or epsom salts, but also of the roentgen rays. If we do this there will be fewer medical malpractice suits filed and less grief for those who help to fight them

Readers of my papers and discussions, as well as the unfortunates who are present when I talk, know that I have from time to time mentioned this sort of thing before. I have repeatedly said that it is better to be safe than sorry, and in my recent series of papers in RADIOLOGY, on "Some Law-suits I have Met," I tried to maintain the same cautionary warning. I expect to continue my talking and writing along these same lines as long as my tongue will wag and my hand hold a pen

Fortunately, radiologists do not seem to present any evidence of idiosyncrasy, but on the contrary, tolerate enormous amounts of punishment in the way of oft-repeated advice, abuse, and reiteration. If that were not true, I might not have the temerity to present this and you would neither listen to it nor read it after it is printed

SURGICAL ANATOMY OF THE ABDOMEN¹

A ROENTGENOLOGIC STUDY

By SAMUEL BROWN, M D, and ARCHIE FINE, M D, Cincinnati, Ohio

THE scope of this paper is concerned with certain principles which have been found helpful in the roentgenologic study of the surgical anatomy of the abdomen. These are as follows:

- (1) The study of the position, shape, and mobility of the diaphragm
- (2) The study of the abdomen by plain views
- (3) The study of the position, shape, size, and the relationship of the

stomach and bowels in various positions

Diaphragm—The diaphragm, situated as it is between the thoracic and abdominal cavities, may be affected by abnormal changes of the organs therein, which may alter its position, shape, and mobility. To enable one to recognize departures from the normal, its roentgen anatomy must be understood. This having been described in a previous publication (1), at-

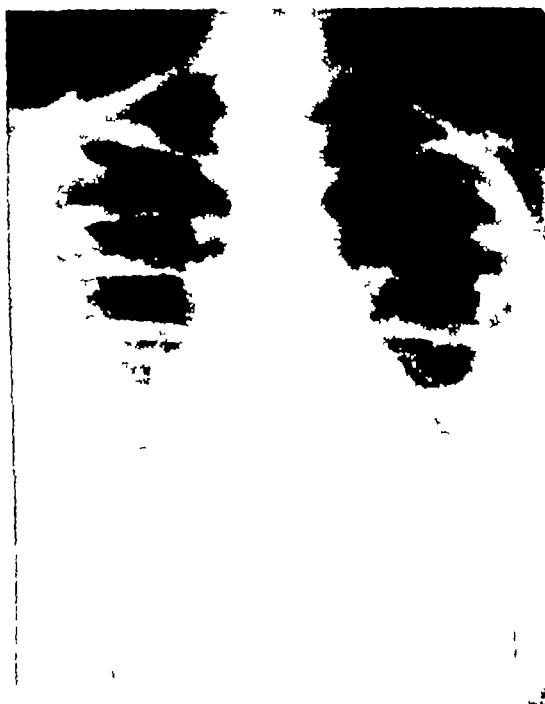


Fig 1-A

Fig 1 A Only the crest of the diaphragm is seen, the rest of its surface being obscured (anterior view)



Fig 1-B

Fig 1 B The entire surface of both leaves of the diaphragm is brought into view. It will be noted that the posterior attachment is on a much lower level than the anterior (lateral view)

stomach and bowels to the neighboring viscera

- (4) The study of the mobility of the gastro-intestinal tract
- (5) The study of the contour of the

tention will be called only to certain anatomical characteristics. Its shape resembles a dome, and is higher anteriorly and medially than posteriorly and laterally. By its central tendon it is attached to the pericardium, and by its lateral projection, to the thoracic cage. In the antero-posterior view of the chest (Fig 1-A),

¹ Presented before the Radiological Society of North America at the Twenty second Annual Meeting at Cincinnati, Ohio, Nov. 30-Dec. 4 1936



Fig 2-A

Fig 2 A The diaphragm is elevated on the right side The lung appears to be free from any abnormal changes (posterior view)

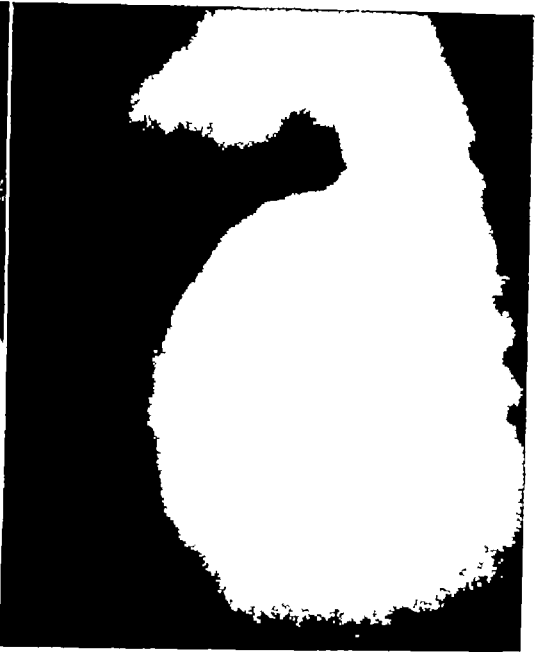


Fig 2-B

Fig 2 B The right diaphragm is elevated through its entire expansion, being on the same level with the crest and thus resembling a 'plateau' frequently met with in cases of subphrenic abscess (lateral view)

only the crest of the diaphragm is seen, the rest of its surface being obscured, in the lateral view (Fig 1-B), the entire extent of both leaves of the diaphragm is brought into view

There are numerous processes which may increase the intra-abdominal pressure, thus altering the shape, mobility, and position of the diaphragm. Among these may be included free fluid or gas in the peritoneal cavity, enlargement of the liver, gaseous distention of the stomach and bowels, extraneous masses, and subphrenic abscess. In all these conditions there is elevation of the diaphragm and more or less impairment of mobility. However, subphrenic abscess is differentiated from these other conditions by the elevation of the posterior boundary of the diaphragm which makes it appear flattened, resembling a "plateau". The posterior costophrenic angle is completely obliterated. Occasionally there is noted evidence of fluid and inflammatory changes in the diaphragmatic pleura and adjacent lung, due to

lymphatic permeation of the infection through the diaphragm

The following case illustrates the "plateau sign of subphrenic abscess"

Miss C C, aged 45 years, was admitted to the Jewish Hospital with clinical and physical findings of pneumonia of the right lung. An x-ray examination of the chest in the dorsal and lateral decubitus position revealed marked elevation of the right diaphragm. The right lung, although decreased in size, appeared to be free from any involvement (Fig 2-A). In the lateral position the right diaphragm was elevated throughout its entire extent, its surface being on the same level with the crest so that it resembled a plateau, while the posterior costophrenic space was completely obliterated (Fig 2-B). Because of the above signs a diagnosis of subphrenic abscess was made. The past history was quite illuminating for it revealed that she had had a cholecystectomy six months previously from which she made an uneventful recovery. After two or three



Fig 3-A

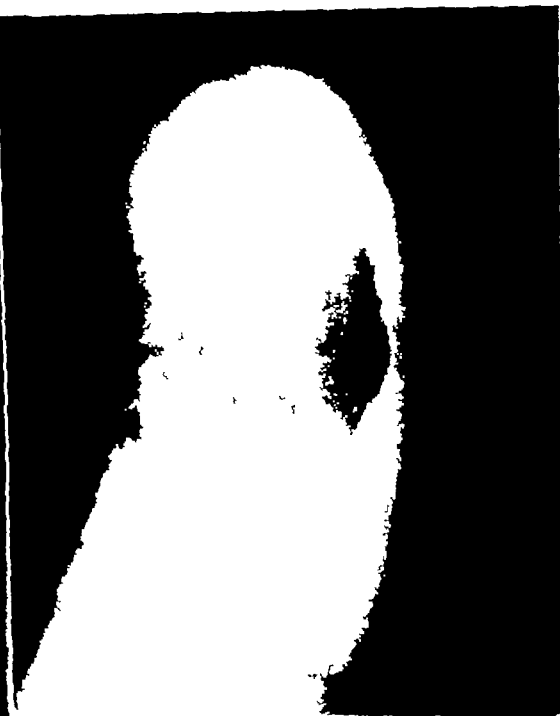


Fig 3-B

Fig 3 A The stomach is displaced to the right. The greater curvature is compressed by the enlarged spleen. The jejunum and splenic flexure are displaced downward (anterior view)

Fig 3 B The stomach is displaced forward, the posterior wall is concave as a result of pressure by the enlarged spleen (left lateral decubitus position)

weeks' delay, because of failure to agree upon the diagnosis, the patient was operated upon and a large amount of pus was found in the subphrenic space. Recovery was complete after a stormy convalescence.

Plain Views of the Abdomen—A plain view of the abdomen in the dorsal or ventral position, and occasionally in the lateral one, should precede the introduction of an opaque medium into any of the hollow viscera. Such views may reveal abnormal dense shadows due to stones in the gall bladder or urinary tract, calcified glands, or metallic foreign bodies, the outline of the liver, spleen, kidneys, and not infrequently, of the gall bladder, the presence of gas in the gastro-intestinal tract and its degree of distention, free fluid or air in the peritoneal cavity, and lastly, extraneous masses in the abdomen. Such an examination will also give one information regarding the skeletal structure.

In the roentgenologic study of the ab-

domen there is no longer any need to adhere to the classical division into nine regions for identifying the position of the various organs. Such a system was applicable at the time when all our information was chiefly obtained from postmortem studies. The roentgenologic method has enabled us to study the living anatomy which reveals a wide variation within normal limits, depending upon the habitus of the individual, *i.e.*, the age, height, weight, and the position of the body as a whole. Thus it is found that the liver, spleen, kidneys, gall bladder, pancreas, and stomach lie high in the abdominal cavity in the sthenic type and low in the asthenic type or anywhere between these two extremes. There is also a difference in the configuration of the organs in sthenic and asthenic types of individuals. In the former the viscera expand in lateral and anteroposterior directions; in the latter, vertically. Before conclusions are



Fig 4-A

Fig 4-A The stomach is displaced upward and to the right due to pressure by an enlarged left kidney (anterior view)

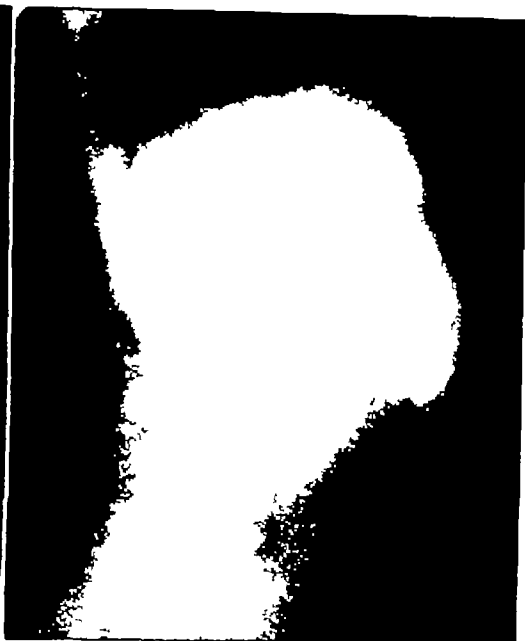


Fig 4-B

Fig 4-B The stomach is displaced forward by the enlarged left kidney (left lateral decubitus position)



Fig 4-C The splenic flexure is in normal position indicating that the tumor is not the spleen but a kidney (anterior view)

drawn regarding the position, shape, and size of any organ, the type of individual must be considered. The frequency of

diagnosis of "dropped stomach" or "dropped colon" would decrease if the normal anatomical variations were better understood. For the roentgen localization of the position of the organs, we have found it of service to divide the abdomen into four regions by the natural boundaries produced by the spine and iliac crests, with the usual nomenclature (R U Q, L U Q, R L Q, L L Q).

Relationship of the Abdominal Viscera —

While the position, shape, and size of the abdominal viscera depend upon the age, height, weight, habitus, and the posture of the individual, the relationship between them remains constant under normal conditions. This factor of relationship is apparently most important for it is the least altered under normal conditions. While variability of the other factors enumerated may be within the limits of normal anatomical variations, alterations in the factor of relationship of organs indicate that there is something abnormal with one or more of the organs.

The roentgenologic study of the inter-



Fig 5-A

Fig 5-B

Fig 5-A The stomach is displaced to the right by a mass in the left hypochondrium (anterior view)

Fig 5-B The stomach is displaced forward, the posterior wall is deformed and attached to the mass. This was proven to be due to a sarcoma arising from the posterior wall of the stomach (left lateral decubitus position)

relationship between the abdominal viscera has been described previously (2, 3, 4, and 5), so that only a brief review is necessary. In the anterior position, the stomach lies in the left upper quadrant, either transversely or vertically or anywhere between these two extremes, depending upon the habitus of the individual and the position of the body. Thus in the sthenic type, the transverse position prevails while in the asthenic, the vertical. The duodenum is found in the right upper quadrant, its exact position being determined by the location of the pylorus. The jejunum usually occupies the left side of the abdomen, the ileum, the right. The colon is located at the periphery with the usual normal variations. The spleen is located to the left and behind the stomach. The left kidney is located to the left of the spine, behind the stomach and inferior to the spleen. The splenic flexure lies below the spleen and at times

under the left diaphragm. The liver is located in the right upper quadrant, its left lobe extending to the left and in front of the stomach. The location of the gall bladder is determined by the position of the pylorus and duodenum. The right kidney lies to the right of the spine behind the liver. The pancreas extends transversely from the duodenal loop to the spleen behind the stomach. The pelvic organs, pelvic colon, sigmoid flexure, and rectum lie in the lower quadrants.

In the right lateral decubitus position, the stomach occupies the anterior part of the abdomen, its anterior wall being parallel with the abdominal wall, and its posterior wall with the spine. The distance between the spine and posterior wall of the stomach varies according to the habitus of the individual, being greater in the sthenic type and less so in the asthenic. The distance between the spine and posterior wall of the stomach gives an indication

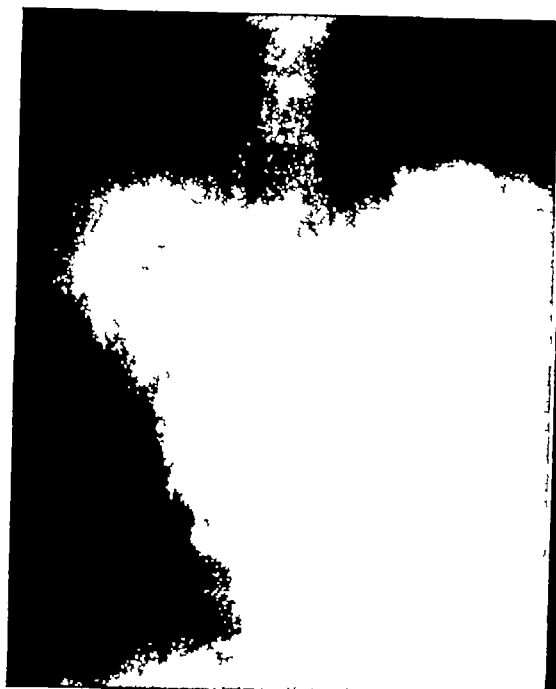


Fig 6-A



Fig 6-B

- Fig 6-A The stomach is displaced to the left by a mass in the epigastrium (anterior view)
 Fig 6-B The stomach is displaced backward, the posterior wall is concave due to pressure by a tumor in front of it This was proven to be due to a tumor of the left lobe of the liver (right lateral decubitus position)

as to the size of the pancreas. The direction of the pylorus is backward and upward, located between the posterior wall of the stomach and the spine. The duodenal bulb is above the pylorus, and the descending duodenum is parallel to the spine and is rather fixed.

In the left lateral decubitus position the direction of the stomach is from above, downward and forward. The degree of inclination depends upon the habitus of the individual, being almost perpendicular to the spine in the sthenic type and parallel in the asthenic type, or anywhere between these two extremes.

Mobility of the Gastro-intestinal Tract—The stomach and intestines are, relatively speaking, freely movable, so that their position and shape will depend upon the neighboring organs and the position of the body. Shifting of the stomach and intestines under normal and abnormal conditions generally takes place in a

definite order, a knowledge of which will enable one to differentiate the origin of tumors.

Several cases have been chosen to illustrate the various shiftings of the stomach and bowels as a result of abnormal changes in the neighboring organs.

Enlargement of the spleen tends to dislodge the stomach to the right in the ventral decubitus position (Fig 3-A) and forward in the left lateral decubitus position (Fig 3-B), the splenic flexure being displaced downward. Frequently there is a considerable concavity in the lateral wall of the stomach because of pressure by the spleen.

Enlargement of the left kidney displaces the stomach to the right (Fig 4-A) and frequently upward in the ventral decubitus position, and forward in the left lateral decubitus position (Fig 4-B). It is differentiated from splenomegaly by the normal position of the splenic flexure (Fig 4-C).



Fig 7-A

Fig 7-A The stomach and duodenum are displaced to the left by a mass in the right lumbar region (anterior view)



Fig 7-B

Fig 7-B The stomach and duodenum are displaced forward due to a large right kidney (right lateral decubitus position)

Tumors in the left upper quadrant arising from the tail of the pancreas or posterior wall of the stomach will displace the latter to the right and forward, the exact origin of the tumor, however, being often difficult to determine. The following case illustrates some of the difficulties which may occur in the diagnosis of a retrogastric tumor.

Mr N F was referred for a gastrointestinal examination because of gastric symptoms. The plain view revealed a large circular mass in the left upper quadrant. After the ingestion of barium the stomach was found to be displaced to the right in the ventral decubitus position (Fig 5-A) and forward in the left lateral decubitus position (Fig 5-B). The posterior wall of the stomach was deformed and apparently attached to the tumor. Such a displacement of the stomach could be induced by a spleen, left kidney, tumor of the tail of the pancreas, or a retrogastric tumor. The left kidney was excluded since its outline was readily seen

in the plain view. It was not enlarged, but displaced downward. The spleen was excluded in spite of all the clinical and surgical arguments to the contrary. It has been our experience that when a spleen enlarges it still retains its usual shape, but in this case the mass was more or less circular. Furthermore, in no instance has there been observed a deformity in the contour of the posterior wall of the stomach as a result of an enlarged spleen. The diagnosis was, therefore, a retrogastric tumor attached to the posterior wall of the stomach so that a partial gastrectomy had to be performed. The pathologic diagnosis was a spindle-cell sarcoma arising from the posterior wall of the stomach.

Enlargement of the liver dislodges the stomach to the left in the ventral decubitus position (Fig 6-A) and backward in the right lateral decubitus position (Fig 6-B). The hepatic flexure is displaced downward. In cases in which both the liver and the spleen are enlarged, the



Fig 8 A



Fig 8-B

Fig 8-A The stomach is displaced to the right. In the middle of the stomach the barium is absent due to pressure by a mass in front of the spine (anterior view)

Fig 8-B The stomach is displaced forward by a mass behind. This was proven to be due to a pancreatic cyst (left lateral decubitus view)



Fig 9 A



Fig 9 B

Fig 9 A The stomach is displaced to the left and the duodenum to the right side (anterior view)

Fig 9 B The stomach and entire duodenum are displaced forward indicating a glandular tumor which retrogressed under x-ray treatment (right lateral decubitus view)



Fig 10 A

Fig 10 A The stomach is displaced to the left and duodenum to the right by a mass in front of the spine (anterior view)



Fig 10-B

Fig 10 B The stomach and duodenal bulb are displaced forward, but the descending portion is in normal position. This indicates that the tumor is within the duodenal loop, hence a pancreatic tumor (right lateral decubitus view)

position of the stomach may remain more or less unaltered due to opposite forces acting upon each other. The stomach becomes narrowed and elongated.

An enlarged right kidney displaces the stomach to the left in the ventral decubitus position (Fig 7-A) and forward in the right lateral decubitus position (Fig 7-B). The hepatic flexure is usually displaced downward but occasionally it may be upward.

An intragastric tumor does not affect the position of the stomach unless there are also retrogastric or liver metastases. This fact is of aid in distinguishing between an intra- and an extra-gastric tumor. A case presenting a deformity in the contour of the stomach in the anteroposterior view should be examined both in the left and right lateral positions. If the deformity of the stomach is due to an intragastric tumor, its position will be found to be normal with the deformed contour either

in the anterior or posterior walls. If the deformity in the anteroposterior view is due to an extra-gastric tumor, the stomach will be found displaced either forward or backward in the lateral positions according to the location of the tumor.

Unlike the liver, spleen, and kidneys, the pancreatic shadow can hardly ever be differentiated upon the film. Nonetheless, the study of the pancreas in relation to the stomach both in the anterior and lateral positions has shown that it is often possible to make an accurate diagnosis of a tumor in cases in which even the clinical and physical findings have failed to suggest its presence.

The effect of a pancreatic tumor upon the position of the stomach and duodenum will depend upon the particular portion of the pancreas involved. Thus a tumor of the head will displace the duodenal bulb and pylorus forward in the right lateral position, and occasionally evidences of



Fig 8-A



Fig 8-B

Fig 8 A The stomach is displaced to the right. In the middle of the stomach the barium is absent due to pressure by a mass in front of the spine (anterior view)

Fig 8-B The stomach is displaced forward by a mass behind. This was proven to be due to a pancreatic cyst (left lateral decubitus view)



Fig 9-A



Fig 9 B

Fig 9 A The stomach is displaced to the left and the duodenum to the right side (anterior view)

Fig 9 B The stomach and entire duodenum are displaced forward indicating a glandular tumor which retrogressed under x-ray treatment (right lateral decubitus view)

SUMMARY AND CONCLUSION

A general survey of the roentgenologic method as applied to the examination of the abdomen is presented

(1) The importance of the study of the diaphragm in the anteroposterior and lateral positions in relation to abdominal lesions is emphasized. Consideration is given to the "plateau sign" in subphrenic abscess, which consists in the elevation of the diaphragm not only as a whole, but also in its posterior half to the same level as that of the crest, with complete obliteration of the posterior costophrenic angle

(2) Attention is called to the usefulness of the study of the plain views of the abdomen in the anteroposterior and lateral positions. Many lesions can be recognized outright. The presence of abnormal dense shadows and their relation to the abdominal organs can be determined with a fair degree of accuracy

(3) A study of the position, shape, size, and relationship of the stomach and bowels reveals the fact that the factor of the relationship is the least variable under normal conditions. Any departure from the normal relationship usually indicates an abnormal change within the abdomen

(4) Consideration is given to the mobility of the stomach and bowels, their position and shape being influenced by the position of the body as a whole and the neighboring organs. It is pointed out that any shifting of the gastro-intestinal tract takes place in an orderly manner both under normal and abnormal conditions, so that a knowledge of these movements may aid in locating and differentiating the origin of a tumor

(5) The value derived from a study of the gastro-intestinal tract in various positions of the abdomen is stressed, for it is pointed out that in the usual anteroposterior view the involved portion of the organ may be obscured by foreshortening or overlapping of the viscera

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DISCUSSION

DR LEO G. RIGLER (Minneapolis, Minn.) This is a very interesting presentation. I have personally been interested in this type of work for a number of years. I just want to bring out a few points that have appealed to me.

In teaching anatomy students, we try to present the normal roentgen anatomy to correlate with the studies which they are making in their first year in school. I know of no better way to present graphically the topographic anatomy of the abdomen than to use a series such as Dr Brown has presented.

Now I find that in dissecting the cadaver, the student has great difficulty in orienting in his mind these relationships between the various organs, but by means of adequate roentgen examination in a variety of positions, particularly in cases in which there is a moderate or even extreme enlargement of any of these organs, one can present to the student a remarkable picture of the relationship between the solid organs of the abdomen and the hollow viscera.

There are just a few points in the surgical diseases of the abdomen that it seems to me have never been sufficiently appreciated in this country. Many years ago Laurell described a sign of peritonitis which we have used with considerable success in many cases and it depends, again, upon a realization of the relationships of the intra-abdominal structures.

In peritonitis there is almost invariably an ileus, so that one gets, without the addition of an opaque substance, a clear visualization of the intestinal tract by reason of the gas within it. In addition, in peritonitis there is almost invariably an accumulation of free fluid to some degree

obstruction in the duodenum are noted. In the anterior position, the pylorus may be pushed to the left and the duodenum to the right. A tumor arising from the body of the pancreas will displace the stomach forward, while the duodeno-junal flexure may be found displaced downward and often partially obstructed. A tumor arising from the tail of the pancreas will displace the stomach forward and at times to the right, depending upon its size.

The following case illustrates a tumor of the body of the pancreas. In the anterior decubitus position there was noted displacement of the barium from the middle of the stomach opposite the spine, apparently due to pressure (Fig 8-A). In the right lateral decubitus position (Fig 8-B), the stomach was displaced forward, and no deformity of contour was noted. It was felt that the tumor had its origin in the pancreas, as an intragastric tumor would show a constant deformity in contour and would not have displaced the stomach. Laparotomy disclosed a pancreatic cyst.

Retroperitoneal Tumors—In retroperitoneal tumors located in front of the spine, the stomach is generally displaced to the left and the duodenum to the right. It is often difficult to differentiate between a neoplasm originating from the pancreas or from the retroperitoneal glands. Evidence of a lesion elsewhere in the body is suggestive of metastases in the retroperitoneal region. The diagnosis is more certain if the mass is affected by roentgen therapy. Forward displacement of the stomach and the entire duodenum indicates a glandular origin of the tumor. The following case illustrates this point.

In the anterior decubitus position (Fig 9-A), the stomach is displaced to the left and the duodenum to the right. The duodenum is noted to make quite a circle around the tumor. In the right lateral decubitus position (Fig 9-B), the stomach and duodenum are displaced forward. Because of the above findings it was felt

that this tumor had its origin in the retroperitoneal glands, and roentgen therapy produced rapid retrogression of the neoplasm. On the other hand, in the following case the anterior view also shows displacement of the stomach to the left and the duodenum to the right (Fig 10-A), but unlike the latter the descending portion remains in normal position and only the pylorus and duodenal bulb are dislodged forward in the right lateral decubitus position (Fig 10-B). Evidently the tumor is located within the duodenal loop and hence must be due to a pancreatic tumor of the head. Upon operation, this was found to be the case.

Tumors having their origin in the pelvis usually displace the large and small bowel upward and laterally.

The Stomach and Intestines—The stomach and intestines are three dimensional structures and, as such, must be studied both in the anteroposterior and lateral positions. Furthermore, as frequently happens, one segment of the gastro-intestinal tract may overlap a neighboring one, thus obscuring it. When these structures are studied from every angle it is often possible to recognize a lesion which may be overlooked in the usual anteroposterior view. This is especially noted in the sthenic type of stomach, the transverse course of which extends from before backward. Such a position results in foreshortening of the viscus in the anteroposterior view, therefore, a lesion located in the middle of the stomach may be obscured and escape detection. In this type of stomach the duodenal bulb is often found behind the pylorus. In the right lateral position the duodenal bulb is visualized and any lesion can be recognized.

In the colon, because of the numerous flexures, various segments may be superimposed and deformities may be obscured in the anteroposterior position. By the study of the colon at various angles it is often possible to separate the segments from one another and bring into view any abnormality present.

CASE REPORTS

ENLARGEMENT OF ONE STERNOCLAVICULAR ARTICULATION A SIGN OF CONGENITAL SYPHILIS¹

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and

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In 1930, a new sign in the diagnosis of congenital syphilis was first described by Higoumenakis (1), namely, the unilateral enlargement of the sternoclavicular articulation. The authors wish to present another case in addition to those previously described in the literature.

CASE REPORT

A white male, aged 56 years, presented himself to the clinic complaining of a severe sore throat which had been present for the past two months and was becoming progressively worse. The physical examination was essentially negative, with the following exceptions. The patient is left-handed. The pharynx, uvula, and soft palate were injected. Deep serpiginous ulcerations were noted on the posterior surface of the uvula, extending on to the soft palate. These ulcerated areas were dark gray in color, having a thick tenacious exudate. The otolaryngologist concluded that the throat involvement was of syphilitic origin. Inspection of the thorax revealed an enlargement of the sternal end of the left clavicle, palpation and comparison with the opposite side revealed a definite thickening of this area (Fig. 1).

Röntgen examination revealed a prominence at the sternal end of the left clavicle (Fig. 2), that of the right clavicle was normal in size. The radiologic conclusion was enlargement of the sternal end of the left clavicle, apparently a manifestation of congenital syphilis.

Serologic examination upon two occasions revealed a three plus Kahn and a negative Wassermann test. Dark field examination was negative for *Spirochæta pallida*.

Past History—The patient gave a history of gonorrhea approximately 25 years previously. There was no history of any syphilitic infection and the patient had been well up to the present time, except for an attack of lumbar myalgia four years previously.

¹ Published with the permission of the Medical Director of the Veterans Administration who assumes no responsibility for the opinions expressed or the conclusions drawn by the authors.



Fig. 1 Enlargement of the sternal end of the left clavicle

Family History—The patient's father died of a cardiovascular (?) disease at the age of 38 years. His mother was also dead, cause unknown, he had no brothers or sisters. The patient has been married for the past 15 years, there was no history of pregnancies or miscarriages.

Progress—Intensive antisyphilitic treatment was instituted, and after a period of three weeks the throat had become practically clear of the ulcers and had lost its normal redness.

DISCUSSION

In the original report by Higoumenakis, he described 23 cases of enlargement and anteroposterior thickening of the sternal end of the clavicle. Seven presented this stigma and no other signs of the disease except a positive Wassermann test, while the remaining 16 cases presented this sign with a negative Wassermann test. In a total of 197 cases of congenital syphilis, he found this sign present in 170, 157 involved the right side, while the remaining 13 involved the left side. Stokes (2), Plushkin (3), and Dorne and Zakon (4) all reported similar findings, with the involvement being on the right side.

The enlargement is readily noted upon inspection and palpation, and is frequently found upon roentgen examination. It is usually unilateral and is present on the right side, except in left-handed persons, in whom it occurs on the left side. The explanation of the development of the exostosis is based upon anatomic, biologic, and mechanical factors. The sternal end of the clavicle first consists of connective tissue and is early transformed into osseous tissue. The spirochetes (*Spirochæta pallida*) carried in the blood stream of the fetus, become lodged in the connective tissue, as in the lymphatic tissues and other organs of the fetus. Here they may remain without any

and one can demonstrate this clearly by the separation of the loops of the bowel because of the entrance of this fluid in between these loops

In occasional cases, the type of obscure or difficult case that Dr Brown has demonstrated, this sign has been to us one of considerable value. Likewise in cases of intra-abdominal hemorrhage, when there is some doubt as to whether a hemorrhage is present, the demonstration of a displacement of the stomach (and the stomach can be demonstrated without barium because of the gas content within it) from the left diaphragm by what appears to be a mass but which, in fact, is simply an accumulation of blood, particularly if films are made with the patient in the Trendelenburg position, will often help a great deal in elucidating the type of process which is present.

There is only one point that has appealed to me insofar as the diagnosis of

these lesions of the head of the pancreas or of the group of peri-aortic lymph nodes upon which Dr Brown spent some time. That is, one has to be very careful in interpreting an enlarged loop of the duodenum as indicating an enlargement either of the head of the pancreas or of the retroperitoneal nodes. In the hypersthenic type of habitus, an examination made in the supine position is likely to give us that appearance of an enlarged loop *under absolutely normal conditions* because of the normal fixation of the duodenum and the mobility of the stomach. So that we have to judge the enlargement of the loop entirely by the upright position, otherwise we may be led into error. If the loop is really enlarged with the patient in the upright position, I think it is a very great significance.

I enjoyed Dr Brown's paper very much—it is such a good review of this type of work.

lower curving upward toward the breast of its fellow

General Examination—The specimen consists of infant twins which are joined together on the ventral surfaces, the junction extending from the fourth rib to the level of the umbilicus. On the surface of the junction of the two, there is an area 6 cm in diameter where the abdominal cavity is covered by a shiny, semi-transparent membrane. This membrane has been ruptured, and sutured together. The attachment of the umbilical cord is at one margin of this area. The heads and upper extremities are normal in appearance. One fetus has normal lower extremities and normal female external genitalia. The other fetus has one normal-appearing extremity, the other lower extremity is entirely absent. This fetus also has no anal opening and no external genitalia. On the perineum of this fetus there is a soft nodular projection of skin measuring about 1 cm in diameter. This has no markings by which it can be identified as part of the sexual apparatus. The fetus which has both legs does not have a sternum. The ribs end



Fig 1 Roentgenogram of conjoined twins



Figs 2 and 3 Specimen

anteriorly in separate cartilages. The fetus with only one lower extremity has a complete thoracic cage, including sternum and ribs.

Body Cavities—Each fetus has two separate pleural cavities. There is only one pericardial sac, which contains a common heart. There is only one abdominal cavity which is common to both fetuses.

Alimentary Tract—Each has an esophagus, stomach, and duodenum which are normal in gross appearance. The duodenums are each about 10 cm in length. They join together forming a common jejunum. This continues for approximately 50 cm, when it divides into two ileums. The one belonging to the more complete fetus extends about 30 cm to the cecum, where there is a normal-appearing

appendix. The colon is about 50 cm in length and communicates to the outside with a normal anal aperture. There is no marking to distinguish the ileum and colon of the incomplete fetus. The change from the characteristics of the ileum to those of the colon is gradual, and no cecum or appendix can be identified. The colon ends in a blind pouch which is quite high in the pelvis.

Respiratory System—Each fetus has its trachea, bronchi, and lungs, with all lobes completely separated. There are no significant pathologic changes noted in the respiratory system.

Cardiovascular System—The pericardial cavity contains a heart which appears to be composed of two hearts joined together at the



Fig 2-A

Fig 2 A Roentgenogram of the sternal end of the left clavicle

Fig 2-B

Fig 2-B Sternal end of the right clavicle in contrast to Figure 2 A

manifestations during childhood. Later in life, when the arms are called upon to do heavy work, the frequent movement of the arms and the constant friction of the clavicle against the sternum set up an irritation. The spirochetes are reactivated and through their toxins produce a chronic periostitis which results in hyperostosis. The enlargement of the sternal end of the clavicle reaches a permanent stage about the age of puberty and thus becomes a characteristic, permanent stigma of congenital syphilis.

SUMMARY

(1) The literature is reviewed and a case of unilateral enlargement of the sternal end of the clavicle is here presented.

(2) This was found on the left side in a left-handed individual.

(3) This corroborated the findings reported by Higoumenakis.

(4) Serology revealed a three plus Kahn as the only other positive finding.

(5) A discussion of the pathogenesis is here presented.

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A CASE OF CONJOINED TWINS

By SYDNEY V KIBBY M D, and O B PRATT M D, *Los Angeles Calif*

This is a report of a case of conjoined twins delivered at the Japanese Hospital of Los Angeles, Aug 31, 1936, by Dr T Ozasa.

The mother is a Japanese woman, 27 years old, married four years. This was her first pregnancy. Her father is dead, the cause not stated. Her mother is living and healthy. She has no brothers or sisters. Her husband is well. There is no history of abnormal births in either the patient's or her husband's family.

Aside from the usual children's diseases, she has always enjoyed good health. The pregnancy was normal and labor initiated one week after the expected date. Twins were diagnosed before the onset of labor.

The first twin started to deliver as a breech, but proceeded only as far as the pelvis when progress was arrested. Attempting to extract

an arm or palpate the shoulder, the obstetrician found his hand obstructed by what felt like placenta, but which ruptured, allowing bowel to escape. Discovering then that the twins were joined together and that the birth by the vaginal route was impossible without destruction of both, he did a Cesarean section and delivered the joined twins through the abdomen.

The mother has made an uneventful recovery with only a slight residual pyelitis.

Following are the reports of the radiographs and of the autopsy.

Radiographs taken after delivery of joined twins show an absence of the bones of the right lower limb of one twin. The lumbar vertebrae and sacral segments of this twin are less developed than the corresponding bones of the other. The sternum of the latter twin is missing. The sternum of the one-legged twin shows the normal six segments, the three

Titusville, Pa, for gastro-intestinal examination

Present Illness—Two years before admission the patient had a severe attack of what he termed "intestinal flu." At that time he had a high temperature, nausea and vomiting, and a severe diarrhea, having as many as eighteen stools a day. He did not consult a physician, because other members of his family had the same condition, which cleared up in a few days. The patient, however, continued to have the severe diarrhea and at the time he was sent to us was having six to eight stools a day. He stated that he had lost about twenty-five pounds in weight during that time.

Past History—The usual childhood diseases were mentioned, but no history of any acute illness was elicited. Four years before he had visited a large clinic because of a vague abdominal discomfort, and a gastro-intestinal series was done, but apparently no pathology was seen at that time.

Examination—On examination of the stomach, and a six-hour plate, no evidence of pathology could be made out. All the barium had left the colon at the end of the 24-hour period.

A barium enema was done, which showed the colon to fill well. The ascending colon was somewhat spastic. No filling defect could be seen at the hepatic flexure. The patient was then turned upon his abdomen and almost instantly the bile ducts became filled with barium.

A careful study of the six-hour examination does show some irregularity at the hepatic flexure, but the true nature of the condition could not be diagnosed from this film.

Air in the bile ducts, which is said to be a diagnostic sign, is not seen on any of these films.



Fig 3 Film taken after the barium had been expelled from the colon. Practically all the barium has remained in the bile ducts. Some barium was still present in the bile ducts twenty-four hours after this film was taken.

The referring physician reports that the patient's condition has improved considerably under medical treatment, he now has only three stools a day, and has gained in strength and weight. He has thus far refused operation.

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BONE CARCINOMA SECONDARY TO CARCINOMA OF THE URINARY BLADDER

A CASE REPORT

B₃ EDWARD L. JENKINSON, M.D. ARTHUR HUNTER, M.D. and EDWARD W. ROBERTS, M.D. Chicago, Illinois

From the Department of Radiology, St. Luke's Hospital

Bone carcinoma as a metastatic manifestation of carcinoma elsewhere is initially a lesion of the bone marrow. Pincy (1) states:

"At birth all the bones of the skeleton except the cranium contain red marrow in which there is no fatty tissue. The vertebrae, sternum, and os innominata contain red marrow throughout life and only a microscopic amount of fat

even in advanced age. The ribs are also storehouses of red cellular marrow throughout life but in advanced age a patch of fatty tissue usually appears at the anterior end of each rib and extends for one inch from the costochondral junction."

This metamorphosis occurs in the long bones in the epiphyses and just below the middle of the shaft and spreads distally more rapidly than proximally, and most rapidly in the distal limb bones. A small patch of red marrow persists in the upper end of each femur and humerus. The vessels of the red marrow are wide and numerous and the velocity of the blood stream is slow. Pincy was unable to demonstrate lymphatics in the marrow. He states that metastases are always in the red cellular marrow and showed the presence of

apices There is only one ventricular cavity and there does not appear to be a complete septum separating the ventricle from the auricle The venæ cavæ and pulmonary veins empty into the common auricle in either fetus, and the aortæ and pulmonary arteries originate at either end of the ventricular cavity In other respects, the blood circulation does not appear to be abnormal

Urinary System—The more complete fetus has two polycystic kidneys, each measuring about 4 cm in diameter The ureters lead to a normal-appearing bladder The incomplete fetus has a collapsed, thin-walled sac in the place of the left kidney There is a cord in the place of the ureter and no bladder can be demonstrated This fetus has no structure resembling the right kidney

Reproductive System—The more complete fetus has uterus, tubes, and ovaries which are normal in appearance The incomplete fetus has one small structure which resembles the fimbriated extremity of a uterine tube There are no other structures which, in any way, resemble genital organs in this fetus

Microscopic Findings—Section of soft nodule from perineal region shows vascular, fibrous tissue covered with stratified squamous epithelium There are a few glands and some hair follicles This does not resemble any of the external genitalia

Section of small structure from pelvis shows what resembles the fimbriated end of a fallopian tube

727 West Seventh St

THE PRE-OPERATIVE DIAGNOSIS OF CHOLECYSTOCOLONIC FISTULA

By JOSEPH T. DANZER, M.D., Oil City Hospital
Oil City, Pa

Although the pre-operative diagnosis of cholecystocolonic fistula has been previously reported, it is by no means a common finding Podlasky (4), in reviewing the literature previous to 1935, stated that he was the second observer to report such a case He credits Judd and Burden (2), whose article appeared

in 1925, with being the first to report this condition Since that time similar findings have been reported in both the American and foreign literature

The case which we report is unusual, because of the mildness of the patient's symptoms at the time of the rupture of the gall bladder into the colon, and because of the complete filling of the bile ducts, which we have found only once (6) in our search of the literature

The patient, E. M., white, male, aged 65 years, was referred to us by Dr. H. J. Anderson,

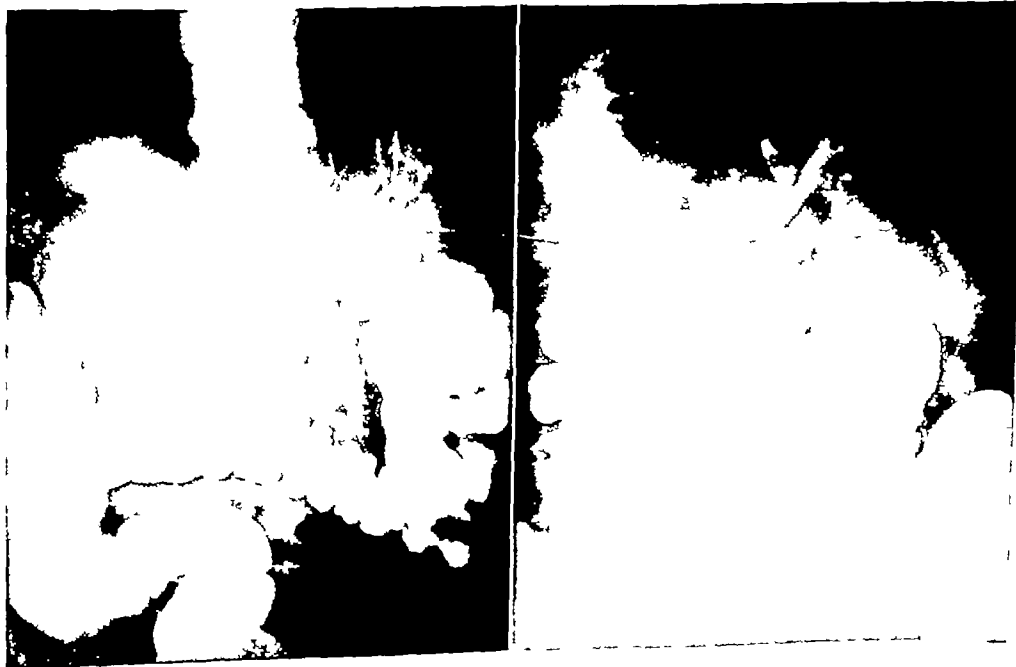


Fig 1 Film taken immediately after filling the colon showing the extensive filling of the bile ducts
Fig 2 Film taken in the right oblique position showing in detail the fistulous tract

were made, followed by roentgenograms. No mention is made of bone metastasis from carcinoma of the bladder.

H G Wells reported a case in 1922 in which the presenting complaint was a large sternal tumor which at postmortem examination proved to be a papillary carcinoma secondary to a small carcinoma of the bladder. This patient had had no symptoms referable to the bladder. Wells quotes Wolff as saying that the infrequency of metastasis is due to the paucity of bladder lymphatics. H L Kretschmer (5) reported five cases, three of which proved to have osseous and visceral metastases at autopsy. All three had symptoms referable to the osseous involvement. Two other cases are cited which were discovered on radiographic examination.

Cecil A Joll (6) cited three carcinoma of the bladder specimens and also referred to specimens of metastasis to the radius, the skull, and the tibia in the Museum of the Royal College of Surgeons and in other hospital museums of London.

In 1,032 cases of metastatic malignant lesions in bone studied by Sutherland *et al* (7) in 1932, nine were due to bladder malignancy. In Geschickter and Copeland's (8) survey of 334 cases of skeletal metastasis, only one was derived from the bladder. In 1934 the Carcinoma Registry of the American Urological Association (9) reported the study of 902 cases of epithelial tumor of the bladder. These cases were collected from varying sources. Thirty-one of the 79 cases coming to autopsy showed metastasis; seven of these showed malignant osseous lesions.

At St Luke's Hospital two of eight cases of carcinoma of the bladder autopsied in the period from January 1, 1935, to the present [November, 1936], showed osseous metastatic deposits. In the case which follows, attention was first directed to a malignancy of bone by the development of a pathologic fracture of the femur. In the cursory survey of the literature cited above no similar occurrence was noted.

A 65-year-old white male was admitted to the hospital June 8, 1936, on the urological service of Dr Harry Culver, complaining of hematuria, intermittently present for five years, nocturia of two years' duration, loss of 50 pounds' weight during the past six months, and pain in the right thigh and calf of four months' duration.

Prior to the onset of these complaints the patient's health had been good. The hematuria was intermittent in character, occurring every two or three months, and usually lasting approximately one week. An additional urinary complaint was diurnal and nocturnal frequency,

micturition occurring every two or three hours. The most troublesome complaint was that referable to the right lower extremity, which had become progressively more painful and progressively weaker during the four months previous to admission to the hospital. The patient required the use of a cane for walking and at times, when he was in bed, it was necessary for him to move his leg with his hands. The pain had first presented itself in the region of the knee but at the time of admission had extended to the thigh and calf and was present most of the time, both day and night. Other than polydipsia and polyphagia, symptoms referable to the patient's diabetes mellitus, he had no other complaints. The latter condition, in all probability, contributed to the etiology of the frequency of urination, although the patient remained aglycosuric on diabetic management without insulin.

The only physical findings on examination were emaciation, muscular atrophy of the right thigh and calf, edema of the right knee, and palpable crepitus medial to the patella. A tender, fusiform swelling was found along the lateral aspect of the middle third of the right femur.

A cystoscopic examination was made June 9, 1936, at which time a large pedunculated tumor was found attached to the left lateral bladder wall in the region of the left ureteral orifice. The bladder was opened suprapubically on June 11, 1936, and the cystoscopic findings were confirmed. The tumor was found to be a large pedunculated mass of tissue attached to the floor of the bladder in the region of the left ureteral orifice. The wall surrounding the attachment was hard and infiltrated. There was an additional small pedunculated, partly necrotic tumor attached to the floor and posterior wall of the bladder. The tumor mass extended through the bladder wall into the perivesical tissues. 125 grams of tumor tissue were removed by loop resection.

The histologic examination of the tumor tissue was reported as follows by Dr Edwin F Hirsch:

"These tissues have the structure of a papillary tumor of the urinary bladder, that is to say, there are papillae with slender, vascular, fibrous stalks of these epithelial cells with remnants of the stalk structure. Papillary carcinoma of the urinary bladder."

Aside from the development of a moderate secondary anemia, the patient's post-operative course was without complication until the eighth day, when he heard something "crack" as he was raising his right leg in bed. This was accompanied by a marked degree of pain. A portable roentgen examination revealed a pathologic fracture of the right femur due to an

carcinoma cells in endothelial-lined channels, quoting Erbhölz as having shown red blood cells in carcinoma containing endothelial-lined

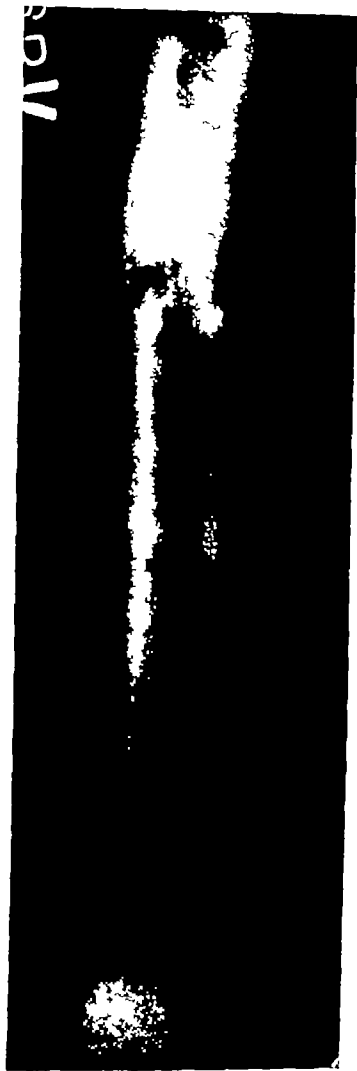


Fig 1 Pathologic fracture of right femur due to osteoclastic metastasis from carcinoma of the bladder

channels. The points of emergence of tumor on bone surface correspond to places of venous exit from the bone.

The site of the earliest deposit is in the medullary cavity at the lower edge of the red marrow in the proximal bones of the limbs and the metastases spread in either direction from their original focus, the proliferation being preceded by an increase in the amount of red cellular marrow. If hyperplasia of the marrow has been evoked by previous anemia the first

deposit may be in the lower part of hyperplastic red marrow. The knowledge contributed by Piney favors the embolic origin of osseous metastases. The passage of the pulmonary barrier can be accounted for by the work of Schmidt, who demonstrated the presence of secondary foci in small pulmonary thrombi. These foci may remain latent, only exceptionally disseminating in the systemic circulation.

Carcinoma of the urinary bladder as a primary focus for osseous metastasis is rare if available statistics can be considered as an indication of its frequency. Ewing (2) does not mention it. The overwhelming preponderance of prostatic carcinoma over bladder carcinoma as a cause for metastatic bone lesions is not in the same ratio as the relative incidence of the primary lesions. The more abundant lymphatic supply of the prostate may be a partial explanation for this difference, and the compact situation of the prostate may favor dissemination, whereas the pressure relations in the bladder permit intra-luminal growth which, in consequence, often assumes a papillary character.

H G Wells (3) states that Schraut, in 1854, described cases of urinary bladder carcinoma with osseous metastases and that Kastner, in 1908, also described such cases. G E Shoemaker (4), in 1911, recorded a case of malignant deposition in the tarsus and metatarsus which developed very rapidly three weeks after thermo-cautery of the bladder tumor. G E Pfahler, in 1917, discussed the roentgen diagnosis of metastatic malignant diseases of bone and quoted Fraenkel's work (1911), which was based on 150 cases that died of carcinoma somewhere in the body and in which sagittal sections of the spinal column



Fig 2 Osteoclastic metastases involving the inner surface of the proximal third of the right femur and both ischia. Primary lesion in the bladder.

EDITORIAL

LEON J. MENVILLE, M.D., *Editor*

HOWARD P. DOUB, M.D., *Associate Editor*

THE COLESCOPIC METHOD OF DEMONSTRATING KNOWLEDGE CONCERNING MEDICAL FACTS¹

The method consists of reproduction of text, drawings, roentgenograms, photographs, and photomicrographs on a strip of moving picture film which may be either projected on a screen or viewed directly by a magnifying apparatus. This method of approach appeals particularly to those who desire to obtain medical knowledge by the visual approach, namely, that of looking at illustrations and reading the captions. This procedure is very popular with those who are pressed for time.²

The writer used two subjects to illustrate the method: (1) "The Roentgenological Diagnosis of Ulcer of the Cap," and (2) "The Pathological Diagnosis of Gastric Neoplasm Based on Unorthodox Archeological Microscopic Criteria." Each of these subjects was considered in two distinct presentations. One was a description of the fundamental principles of roentgenologic or pathologic diagnosis, the other an elaborate description of the criteria, amply illustrated with drawings, roentgenograms, and photomicrographs. The text was illustrated with innumerable drawings to convey the writer's conception and exactly the same text described the roentgenograms and photomicrographs which were the source of his knowledge concerning these criteria.

Three of the four presentations shown were so clear and concise that the subject could be understood by physicians who were neither roentgenologists nor pathologists, the clinical significance and application to the medical and surgical treatment of both gastric and cap ulcers became apparent.

The fundamental principles underlying what the writer has called "The Archeologic Approach Based on Unorthodox Microscopic Criteria" were very comprehensive and may

have a profound influence on the whole subject of pathology.

The fourth presentation was too elaborate and too comprehensive for an exhibit. It required more time and thought than could be devoted by those attending the meeting, where there was such a wealth of excellent articles on the regular program. In this elaborate presentation the writer submitted text, drawings, and photomicrographs demonstrating 26 unorthodox microscopic criteria of gastric neoplasm which were the direct antithesis of those of simple gastric ulcer, making 52 pathologic findings in all. These were elaborately described by the text and illustrated by 181 drawings and photomicrographs. The drawings conveyed my conception. The photomicrographic findings were submitted in proof of the accuracy of my observations. This demonstration required over two hours to wade through and even then, one would have a desire to go over it again, in answer to the criticism of its being too lengthy. I simply stated that it was not even long enough to convey fully the significance of these 26 unorthodox microscopic criteria based on the new archeologic approach.

These films may be viewed individually with a magnifying glass as one would read the text and look at the illustrations of an article in a book or they may be projected upon a screen for the dissemination of this knowledge to medical societies.

The writer also had an incomplete manuscript for the intensive teaching of gastrointestinal roentgenology which will be made available if there is a demand.

This created enough interest so that several authors, Kirklin, Portmann, Glasser, and Rigler among others, agreed to submit material to be reproduced and disseminated in this manner. It is hoped that other investigators may employ this method of circulating scientific knowledge in instances in which a great number of roentgenograms, photographs, photomicro-

¹ Presented at the Cincinnati Meeting of the Radiological Society of North America, Nov 30-Dec 4, 1936.

² Those who really have significant material to disseminate are urged to communicate with the writer or with the American Medical Films, Inc., a firm which is attempting to produce and distribute this material.

osteoclastic type of metastatic tumor. There was a similar osteoclastic lesion involving the proximal third of the right femur on the medial surface, with involvement of the lesser trochanter. Further roentgen studies at this time indicated similar destructive, osteoclastic lesions involving the left and right ischium. There was no evidence of osseous metastatic lesions of the lumbar spine nor of the left femur.

The fracture was immobilized in a cast and on the twenty-fifth post-operative day the patient was discharged from the hospital.

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graphs, or charts are essential to a proper understanding of the subject or in proof of the clinical results, as in a large series of treatment cases

LEWIS GREGORY COLE, M D

36 East 81st St
New York City

PRESIDENT JOHN D CAMP, M D

John Dexter Camp, President of the Radiological Society of North America for the ensuing year, is a native of Massachusetts and is 38 years of age. He received the degrees of B S, Ch B, and M D, successively, from Boston University in 1920, 1921, and 1922, respectively. His training in radiology was obtained as a Fellow in The Mayo Foundation from 1922 to 1924. Thereafter he became assistant roentgenologist at Massachusetts General Hospital, entered into private practice in Boston in 1927, and was appointed consulting roentgenologist to The Palmer Memorial, Massachusetts Women's, Leonard Morse and the Westerly (Rhode Island) Hospitals. In 1928 he was called to the post of consultant in the Section on Roentgenology at The Mayo Clinic, where he has since continued. His contributions to the literature have covered a wide range of subjects including the roentgenologic anatomy and pathology of the sella turcica, the diagnosis of tumors of the brain and of the spinal cord, the osseous changes accompanying hyperparathyroidism, and the value of the niche as a diagnostic sign of gastrojejunal ulcer. During his membership in the Radiological Society he has served variously as Assistant Editor of its Journal, and Counselor for the States of Massachusetts and Minnesota. For three years prior to his election to head the Society he was a member of its Executive Committee.

ALBERT MILLER, M D

PRESENTATION OF THE GAVEL

Several years ago, Dr Pfahler presented to the Radiological Society of North America, this gavel. Inscribed upon it are the names of the past Presidents of our Society. It is given to the incoming President each year as a token of esteem which Dr Pfahler has for his fellow-radiologists. It is also a token of authority and leadership. It affords me a great deal of pleasure to present this gavel to a man who not only possesses leadership, but

because of his learning and scholarly achievements is recognized—not only in this country, but abroad—as one of America's leading radiologists. Only last Sunday he arrived in New York, after spending three months in Europe. I do not know what decorations he received from foreign countries, or what habits he acquired—I only hope that he does not expect me to present this gavel to him as they would in France—that is, with a kiss! It gives me a great deal of pleasure to present to Dr John D Camp, our new President, this gavel.

THOMAS A BURCHAM, M D

ADDRESS OF THE RETIRING PRESIDENT

CINCINNATI ANNUAL MEETING

As President of the Radiological Society of North America during the past year, I have had an opportunity to become acquainted with a large number of the members and this contact has enabled me to more fully understand the functions, problems, and needs of our Society, and to have a small part in their solution. I am grateful for having been afforded the opportunity of serving you, and I wish to express my appreciation of the honor you bestowed upon me.

The untiring efforts of the entire membership in helping me carry out the duties of this office are acknowledged. Because of the earnest and efficient manner in which each chairman and the individual members of the different committees performed their duties, my responsibilities were lessened. This spirit of co-operation was conducive to a year of happiness long to be remembered.

Never in the history of the Society has its business been more efficiently conducted than at present by the officers and members of the various committees. The sound financial condition of the Society and of RADIOLOGY, our Journal, is shown in the report of the Secretary-Treasurer. This is due to the efficiency of the Executive Committee and the untiring efforts and excellent business judgment of the Secretary-Treasurer, Dr D S Childs.

No single method of diagnosis and treatment of human ailments has shown such a rapid advance during a like period of time as has the x-ray since the date of its discovery. This advancement has been made possible by research and the expenditure of large sums of money by the manufacturers of x-ray appara-



JOHN D. CAMP M.D. President of the Radiological Society of North America

necessity. However, since the change in the attitude of the national x-ray organizations whereby they have undertaken to establish a liaison between the different societies and to correlate their efforts with a division of the teaching, political, and economic problems, I am wavering in this opinion. I feel that the traditional associations established by the national organizations over a long period of years are desirable and should be a cherished memory in the minds of the members of the different organizations.

With a continued spirit of co-operation, and a solidarity of purpose, we can expect advances in the future as great as those which have been made in the past. Revolutionary changes are taking place in reference to the care of the sick and we may expect further changes in the future, whereby the services of the radiologists will be extended to a large percentage of our population who are now denied such service because of their inability to pay. If we can be a part of such a service, and can do our share in the relief and care of sick and suffering humanity, we should welcome such changes for the betterment of society. We must be assured, however, that these changes will not mean that we become subservient to such bureaucratic and lay control as would jeopardize a great and noble profession.

THOMAS A. BURCHAM, M.D.

ANNOUNCEMENTS

REPORT OF THE COMMITTEE ON SCIENTIFIC AWARDS

Annual Meeting, 1936

The Committee on Scientific Exhibit Awards took the following factors into consideration in judging the merits of the exhibit at the Twenty-second Annual Meeting of the Radiological Society of North America:

- 1 Originality of conception,
- 2 The personal effort shown in the exhibit,
- 3 The excellence of technical presentation,
- 4 The self-explanatory nature of the exhibit,
- 5 The completeness of the exhibit,
- 6 Whether this is the first time the exhibit has been shown in whole or in part.

For the first award, we designate Dr. Henry Snure and Dr. George D. Maner for their

exhibit entitled "Roentgen-ray Evidence of Metastatic Malignancy in Bone."

For the second award, we were unable to decide between the exhibits of Dr. Edward B. Benedict and Dr. Richard Schatzki, and that of Dr. Rudolph Schindler and Dr. Frederick Templeton. Consequently, we designate both of them for the second award.

For the third award, we designate Edith H. Qumby, M.A., and Dr. William S. MacComb for their exhibit entitled "Recovery of Human Skin from Irradiation."

For Honorable Mention we designate Dr. Robert H. Millwee, of Dallas, Texas, for his Scanlogram exhibit.

We wish to mention also the excellent exhibit of Dr. Wendell G. Scott and Dr. Sherwood Moore on "Roentgen Kymography," and we wish to thank Dr. Samuel Brown for the instructive and extensive exhibit which he presented to avoid bare spaces in the view boxes.

We should like to express, in behalf of the Society, thanks and appreciation to the participants in this year's exhibit, it has been a distinctly worth-while supplement to the value of our Annual Meeting.

Respectfully submitted,

THE SECRET COMMITTEE

AWARD OF GOLD MEDALS

In awarding the gold medals of the Radiological Society of North America at the Twenty-second Annual Meeting of the Society, President Thomas A. Burcham spoke as follows:

Eleven years ago Edwin C. Ernst, M.D., and Otto Glasser, Ph.D., were appointed as Chairman and Sub-chairman of the Standardization Committee on X-ray Measurements of the Radiological Society of North America. The members of this Society are familiar with their work, and aware that their efforts to secure the adoption of an international standard of measurement and to develop simple, economical, and practical methods of measuring x-rays have been a potent factor in promoting the greatest advances in the field of x-ray therapy since the invention of the hot cathode tube. Their work has been closely interwoven and it is eminently fitting that this Society, in honoring one, should honor both.

Therefore, Edwin C. Ernst, by virtue of the authority vested in me by the Board of Censors

tus It is now possible to put very efficient x-ray equipment in the hands of a large number of individuals with little or no knowledge of the physics or mechanics necessary to operate the equipment. It is possible with a few hours of instruction for a physician or a technician, to make very good radiographs of the human body. These assertions are not made with the idea of censuring the manufacturers for the wide distribution of x-ray equipment, but are mentioned to show the tremendous advances that have been made. The broad distribution of x-ray equipment has in many instances created in the minds of the lay people, and physicians as well, a desire for competent x-ray examinations. It has acquainted the physicians with the far-reaching possibilities of x-ray examinations in the hands of a trained radiologist.

An important function of the Radiological Society at this time is to acquaint the physician, who is desirous of entering the field of radiology, with the necessity of thorough training and to emphasize his responsibility in this regard. The field of diagnostic radiology is so broad in its application that it is necessary for those desiring to enter this specialty to have not only the fundamental training of the surgeon and clinician, but also a knowledge of the many different specialties. In fact, radiology covers practically all of the specialties, and is now being divided into different specified fields. Unless the training of the young radiologist includes a knowledge of the basic sciences, in addition to a thorough training in clinical medicine, he will not possess the education necessary for success in his chosen field. His training should be such that he can take his place as a consultant along with the surgeon and internist. The training now given in many of our teaching institutions and clinics should be encouraged and continued, keeping these thoughts always foremost: first, that the training leading to qualification as a radiologist is a post-graduate study and qualification can be attained only after years of study and application, second, that radiology must be interwoven into the practice of medicine as a whole, third, that the practice of radiology is the practice of medicine and cannot be separated into professional and technical branches.

The work of the American Board of Radiology is to be commended and its members congratulated on the excellent and unbiased manner in which the examinations have been conducted. The Diplomates of this Board

hold in their hands the future destiny of radiology. In a very short time the influence of these men will be paramount in determining the future training in radiology. They will also outline the policies to be adhered to in hospital practice, they will designate the requirements for membership in national x-ray organizations. They are now receiving the recognition of the American Medical Association, which is the only avenue of membership to organized medicine.

Within the last few years the treatment of cancer has been given over to the radiologists, and, as radiologists, we must accept this responsibility. A great deal of confusion exists in the field of x-ray therapy at this time, partly due to the uncertainty as to the quality and quantity of x-ray administered for different specific conditions, and partly due to the many and varied technics now being employed by a large number of radiotherapists throughout the world. This is unavoidable, and as it should be, for from the records of their experiments, and as result of their efforts, will finally emerge the most efficient technic to be employed in the treatment of certain specific conditions to insure the greatest degree of success. Because of the time necessary to accumulate accurate statistics, one is inclined to believe that the clinical application of x-ray has not advanced as rapidly as the development of equipment, but time is a necessary factor in determining results in all treatments. However, with the instruments of precision now available great care can and must be exercised in recording the different factors in the application of x-ray dosage, including complete histories and pathologic reports, with a view to an honest and unbiased report of the results obtained.

During the last few years we have heard a great deal about economic, political, and social changes in the different countries of the world, and we have heard much discussion as to how these changes, if put into effect in this country, would affect the practice of medicine. These discussions have become so general and so frequent that we, as physicians, cannot avoid them if we are to exist as members of organized medicine. We must face these issues.

As a result of the changes which have already taken place, I have stated on more than one occasion that there is a need for unity, even to the point of consolidation of our national radiological organizations. This statement was based on the question of economic

not later than May 1, 1937. The abstracts will be published in the three official languages of the Congress at least six weeks prior to the meeting of the Congress. The full text will also be translated into the other two official languages and will be projected on the screen in those languages while it is being delivered.

Prompt transmission of the abstract and full text will greatly facilitate the work of translation, publication of the book of abstracts, and preparation of the films for projection.

RADIOLOGICAL SECTION OF THE LOS ANGELES COUNTY MEDICAL ASSOCIATION

At the last meeting of the Radiological Section of the Los Angeles County Medical Association, the following officers were elected to serve for 1937

President, D. R. McColl, M. D.

Vice-president, John F. Chapman, M. D.

Treasurer, Henry Snure, M. D.

Secretary, E. N. Liljedahl, M. D.

Meetings are held on the second Wednesday of the month at the County Society building.

IN MEMORIAM

RESOLUTION OF THE PHILADELPHIA ROENTGEN RAY SOCIETY CONCERNING THE UNTIMELY DEATH OF WILLIS FASTNACHT MANGES

WHEREAS, our beloved fellow-member, Willis Fastnacht Manges, was taken from us by death on Nov. 24, 1936, and

WHEREAS, we fully appreciate the magnitude of our loss, and desire to express and permanently record our thoughts upon this sad occasion, be it therefore

RESOLVED, that the following statement be spread upon our minutes and a copy sent to the bereaved family of our departed friend

Willis Manges combined, in rare degree, the qualities of scientist, teacher, physician, and gentleman. Born at Luthersburg, Penna., in 1876, he attended Gettysburg College, then matriculated at Jefferson Medical College and was granted the degree of Doctor of Medicine in 1903. Twenty-five years later (1928) Gettysburg recognized his pre-eminence by bestowing upon him the Honorary Degree of Doctor of Science.

He began the practice of radiology when that specialty was still in its infancy. He can, therefore, be listed as one of radiology's pioneers. From the very beginning of his work he gave evidence of unusual ability along investigative lines. Never content merely to follow the beaten path, he was often the first to try out a new technic or method. Radiologists all over the world are aware of their debt to him, for he not only accomplished fundamental researches, he enriched the scientific literature with many a lucid description of his results. To mention only the more outstanding of his contributions, we call attention to (1) his announcement of the first mathematically accurate method of roentgen pelvimetry, in the "American Quarterly of Roentgenology" for 1911, (2) his introduction of pyeloscopy as an adjunct and control for pyelography, first reported in the "American Journal of Roentgenology" for 1918, (3) his development of an efficient organization at Camp Greenleaf where hundreds of Army Medical Officers were given training in roentgenology under his direction during the World War, (4) his vivid description of the mechanism and diagnostic significance of obstructive emphysema and atelectasis, in connection with foreign bodies and various endobronchial lesions, (5) his work with Chevalier Jackson in the application of biplane fluoroscopy to the problem of recovering foreign bodies from the air and food passages, (6) his successful application of the biplane fluoroscope to the problem of localizing and removing non-magnetic foreign bodies from the eye.

As a teacher, Willis Manges was gentle, lucid, painstaking, and inspiring. Fortunate indeed are those who can say, "I was his understudy." And fortunate was his Alma Mater in her choice of Willis Manges as Professor of Roentgenology.

Willis Manges was first and foremost a physician. He realized from the beginning of his work in roentgenology that the importance of developing technic must not be permitted to turn the physician-roentgenologist into a technician. He warned us, frequently, that we must be physicians first, roentgenologists second. As a Charter Member of the American Board of Radiology his voice was raised in defense of proper standards in this matter.

Finally we pay tribute to Willis Manges the man. The quality of his friendship warmed our hearts. His personal charm will never be

and the Executive Committee of the Radiological Society of North America, I have the honor to present you with the gold medal of the Society in recognition of the following achievements

You suggested and urged the appointment of a Committee on Standardization of X-ray Measurements in this Society

As Chairman of that Committee, you promptly recognized the magnitude of your task and applied for help to the United States Bureau of Standards

Working against almost unsurmountable obstacles, you obtained the interest and enlisted the assistance of those powerful enough to authorize and finance the United States Bureau of Standards in a task which, by its successful accomplishment, has brought great honor to our country among the nations of the world

By your energy, your unselfish devotion to your purpose, your readiness to compromise and to be content with less than perfection, and your amiable personality, you played a large part in the adoption of an international unit of λ -ray measurements

And to you, Otto Glasser, by virtue of the same authority, I have the honor to present the gold medal of the Society in recognition of the following achievements

You were probably the first to construct a small ionization chamber whose wall had the same absorption value as air

You designed, constructed, and have constantly improved a measuring instrument simple enough to be used by any practising radiologist, accurate enough for all practical purposes, and sold at a price within the means of everyone

As Sub-chairman for many years of the Committee on the Standardization of X-ray Measurements of this Society, you labored unselfishly and modestly. You recognized the great need of medical radiologists for greater accuracy, and in spite of your scientific training, you were content to advance little by little instead of solving the problems assigned to you and your Committee all at one time

Without ever claiming credit for your own efforts, you played a large part in the adoption of an international unit of x-ray measurement. By your sincerity of purpose, your unselfish devotion to scientific accuracy, and your warm-hearted and lovable personality, you have been able to compose many national and

international differences arising in the course of the labors of the International Committee on X-ray Units

MID-WESTERN RADIOLOGISTS

The first annual Clinical Conference of Mid-western Radiologists is to be held in Rochester, Minnesota, Feb 12 and 13. All radiologists are invited to attend. Headquarters will be at the Kahler Hotel.

If there is a sufficient number making the trip from Chicago to Rochester, there will be a special train leaving Chicago on Thursday afternoon, February 11.

EASTERN CONFERENCE OF RADIOLOGISTS

An Eastern Conference of Radiologists is to be held in New York City, January 29 and 30, under the sponsorship of the New York Roentgen Society. Headquarters will be at the Hotel Pennsylvania.

Further details can be learned from Dr. E. F. Merrill, 30 West 59th Street, New York City.

THE PROGRAM OF THE FIFTH INTERNATIONAL CONGRESS OF RADIOLOGY

Contributions for the program of the Fifth International Congress of Radiology are now being received. The Congress will be held at the Palmer House, Chicago, Sept 13-17, 1937.

The rules of the International Congress require that participants in the program be members of the Congress. Announcements setting forth the requirements for membership have been mailed to all members of radiological societies in all countries.

All who wish to take part in the program should apply to the President, Dr. A. C. Christie, 1835 Eye Street, Washington, D. C., stating the subject which they wish to present and at the same time should send their application for membership in the Congress to The Secretary, Fifth International Congress of Radiology, 2561 North Clark Street, Chicago, Illinois.

If possible, the application for place on the program should be accompanied by a 500-word abstract and in any case such abstract must be received by the President not later than April 1, 1937, and the full text of the paper

DIPLOMATES OF THE AMERICAN BOARD OF RADIOLOGY December 31, 1936

The following is a complete list of the radiologists who have appeared before the Board and passed a satisfactory examination in the field indicated

Name	Address	Field
1 Ackemann, H W	Rockford, Ill	Radiology
2 Adair, Frank E	New York, N Y	Therapeutic Radiology
3 Albert, Simon	Providence, R I	Radiology
4 Alexander, F K	Philadelphia, Pa	Radiology
5 Allen, B M	Wilmington, Del	Diagnostic Roentgenology
*6 Allen Bundy	Tampa, Fla	Radiology
7 Allen, Kenneth D A	Denver, Colo	Radiology
8 Allen, Lewis G	Kansas City, Kans	Radiology
9 Allen, M Lowry	Philadelphia, Pa	Radiology
10 Allen, William E, Jr	St Louis, Mo	Roentgenology
11 Alley, Reuben G	Pittsburgh, Pa	Diagnostic Roentgenology
12 Allison, R. G	Minneapolis, Minn	Roentgenology
13 Altman, W S	Quincy, Mass	Radiology
14 Ames, Forrest B	Bangor, Me	Roentgenology
15 Anderson W D	Memphis, Tenn	Roentgenology
16 Andrews J Robert	Cleveland, O	Radiology
17 Ané J N	New Orleans, La	Radiology
18 Anspach William E	Chicago, Ill	Roentgenology
19 Archer, Vincent W	University, Va	Roentgenology
20 Arens, Robert A	Chicago, Ill	Radiology
21 Arneson, A N	St Louis, Mo	Therapeutic Radiology
22 Ashbury, Howard E	Baltimore, Md	Radiology
23 Atkins S M	Waterbury Conn	Roentgenology
24 Aurelius, J Richards	St Paul, Minn	Roentgenology
25 Avery, Philip S	New Brunswick, N J	Roentgenology
26 Bachman, M H	Youngstown, O	Roentgenology
27 Bacon, Ralph D	Erie, Pa	Radiology
28 Bader, E R	Cincinnati, O	Radiology
29 Bailey, C O	Los Angeles, Cal	Therapeutic Radiology
30 Bailey, Wilbur	Pasadena, Cal	Radiology
31 Baker, Charles F	Newark, N J	Roentgenology
32 Baker, Edgar C	Youngstown, O	Radiology
33 Ball, Clarence F	Rutland, Vt	Therapeutic Radiology
34 Ball, Robert P	Chattanooga, Tenn	Roentgenology
35 Barfield Carter, M	Birmingham, Ala	Roentgenology
36 Barker, Walter C	Philadelphia, Pa	Radiology
37 Barker, W Allen	Petersburg, Va.	Roentgenology
38 Barnes, John M	Buffalo, N Y	Roentgenology
39 Barnett, Arthur F	Eugene, Ore.	Radiology
40 Barr, Richard E	Beaumont, Tex	Therapeutic Radiology
41 Barrow, S C	Shreveport, La	Radiology
42 Barth, Earl E	Chicago, Ill	Roentgenology
43 Bauer, August A	Chicago, Ill	Roentgenology
44 Baum, Samuel M	New York, N Y	Therapeutic Radiology
45 Baxter O D	Sumter S C	Radiology
46 Beals, John A	Greenville, Miss	Radiology
47 Beeler, Raymond C	Indianapolis, Ind	Radiology
48 Beilin, D S	Chicago, Ill	Radiology
49 Bell, A L L	Brooklyn, N Y	Roentgenology
50 Bell, J C	Louisville, Ky	Roentgenology
51 Bendick, Arthur J	New York N Y	Radiology
*52 Benishak, Werner L	Aurora, Ill	Roentgenology
53 Benjamin, Emanuel W	Providence R I	Radiology
54 Berg, H Milton	Bismarck, N D	Radiology
55 Bernath Gerald J	Detroit, Mich	Diagnostic Roentgenology
56 Bernstein J H	New York, N Y	Radiology
57 Bethea, W R	Memphis, Tenn	Roentgenology
58 Betts, Arthur	Spokane, Wash	Radiology
59 Birdsall, Edgar	Glens Falls N Y	Diagnostic Roentgenology
60 Birkelo, C C	Detroit, Mich	Roentgenology
61 Bishop, Paul A	Philadelphia, Pa	Radiology
62 Blackett, Charles W	Boston, Mass	Roentgenology
63 Blaine Edward S	Los Angeles Cal	Roentgenology
64 Blake T W	Rochester, Minn	Radiology
65 Bliss Gerald D	Altoona Pa	Radiology
66 Bloom, Arthur R	Detroit, Mich	Diagnostic Roentgenology

*Deceased



The late WILLIS F. MANGES, M.D.

forgotten. His generosity and unselfishness made the world a better place for us to live in. He set an example to all in his integrity and character. His passing has made us poorer, as his years with us made us richer. We glory in his achievements and will ever cherish the memory of his years in our company.

COMMUNICATIONS

THE SOUTH CAROLINA X-RAY SOCIETY

The first regular fall meeting of the South Carolina X-ray Society was well attended. It was unanimously voted to make it a second regular meeting, the other regular meeting to be at the time and place of the State Medical Association meeting. This fall meeting will always be in Charleston on the first Thursday

in November and will coincide with the annual Founder's Day celebration of the State Medical College.

The program on Thursday, Nov 5, 1936, held in the Medical College of the State of South Carolina, Charleston, S. C., was as follows:

- 1 A Discussion of Supervoltage Therapy Installations, R. B. Taft, M.D.
- 2 Treatment of Cancer of the Breast, T. Hutson Martin, M.D., and Augusta Willis, M.D.
- 3 The Effects of Irradiation on Normal and Abnormal Cells, J. Hampton Hoch, D.Sc.
- 4 Skin Reactions and Skin Recovery, Hillyer Rudisill, Jr., M.D.
- 5 The Pathological Grading of Tumors, Thomas Peery, M.D.
- 6 Microscopic Changes in Tumors Following Irradiation, Harold Wood, M.D.

HILLYER RUDISILL, JR., M.D., *Secretary*

"PLANEOGRAPHY"

I have taken the liberty of coining the term, "planeography." It has been used in two articles: "Planeography, Localization, and Mensuration 'Standard Depth Curves,'" *RADIOLOGY*, August, 1936, p. 168, and "The Planeogram: Analysis and Practical Application, with Especial Reference to Mensuration of the Pelvic Inlet," *RADIOLOGY*, December, 1936, p. 732. It should not be confused with terms such as "planigraphy," "tomography," "stratigraphy," etc. "Planeography" refers to the differentiation of *all* the individual planes of which an object is composed from two "ordinary" roentgenograms. The method has been extended to embrace the entire field of localization and mensuration. The other terms refer to a procedure which distorts all the points of an object except those in *one* particular plane. The points in this one plane appear in the roentgenogram; all the other points are effaced. Each procedure has its field of usefulness and limitation; each is entirely different from the other in method and in scope. Different appellations are warranted.

JULIUS KAUFMAN, M.D.

142	Costolow, William E	Los Angeles Cal	Therapeutic Radiology
143	Cram, C F	Corpus Christi, Tex	Radiology
144	Cramp, G W	Brooklyn, N Y	Roentgenology
145	Crane, A W	Kalamazoo Mich	Roentgenology
146	Crawford, Helen L	Winona Minn	Roentgenology
147	Crosby, Leonard G	Denver, Colo	Radiology
148	Crossan John W	Los Angeles Cal	Diagnostic Roentgenology
149	Crowder, E R	Evanston, Ill	Roentgenology
150	Cunningham Lester W	Mandarin, Fla	Roentgenology
151	Curran Francis W	Brooklyn, N Y	Roentgenology
152	Cushway B C	Chicago, Ill	Radiology
153	Dann David S	Kansas City, Mo	Radiology
154	Dannenberg, Max	Brooklyn, N Y	Roentgenology
155	Danzer Joseph T	Oil City, Pa	Radiology
156	Dauksys Joseph	Excelsior Springs, Mo	Diagnostic Roentgenology
157	Davidson, Sol C	Rochester, N Y	Roentgenology
158	Davis, Ernest L	Springfield Mass	Roentgenology
159	Davis, F M	San Antonio Tex	Diagnostic Roentgenology
160	Davis H E	Chicago, Ill	Radiology
161	Davis Henry B	Lancaster Pa	Radiology
162	Davis Kenneth S	Los Angeles Cal	Roentgenology
163	Davison C O	Poughkeepsie, N Y	Radiology
164	Davison, R Winthrop	Trenton, N J	Roentgenology
165	Debbie Anthony G	St Albans N Y	Diagnostic Roentgenology
166	Decker Fred H	Peoria, Ill	Radiology
167	Dempster, J H	Detroit Mich	Diagnostic Roentgenology
168	Derr, John S	Frederick, Md	Roentgenology
169	Desjardins, Anatole	Wilkes Barre Pa	Roentgenology
170	Desjardins A U	Rochester Minn	Radiology
171	Deweese, E R	Kansas City, Mo	Radiology
172	Dick, Paul G	Chicago Ill	Roentgenology
173	Dickinson, J C	Tampa Fla	Roentgenology
174	Dixon, George S	New York, N Y	Diagnostic Roentgenology
175	Donaldson, S W	Ann Arbor Mich	Roentgenology
176	Doub Howard P	Detroit, Mich	Radiology
177	Doughty, William M	Cincinnati, O	Radiology
178	Downing, Robert E	Terre Haute, Ind	Radiology
179	Downs, Elwood E	Woodbury N J	Radiology
180	Drane Robert	Savannah Ga	Roentgenology
181	Dresser, Richard	Boston Mass	Radiology
182	Duckworth Roy D	White Plains N Y	Roentgenology
183	Duckworth, Willard D	New Rochelle, N Y	Roentgenology
184	Duffy James J	New York, N Y	Therapeutic Radiology
185	Dunham H Kennon	Cincinnati O	Diagnostic Roentgenology
186	Durrance Fred Y	Houston Tex	Roentgenology
187	Eastland, William E	Oklahoma City, Okla	Therapeutic Radiology
188	Eastmond Charles	Brooklyn, N Y	Roentgenology
189	Edeiken Louis	Philadelphia Pa	Radiology
190	Edwards Harold G F	Shreveport La	Radiology
191	Edwards, J Bennett	Englewood, N J	Roentgenology
192	Egbert W L	Chester Pa	Diagnostic Roentgenology
193	Ehrenpreis, Bernard	Brooklyn N Y	Roentgenology
194	Ehrlich David E	New York, N Y	Radiology
195	Eldridge Watson W Jr	Washington D C	Roentgenology
196	Eley, Clayton W	Norfolk Va	Roentgenology
197	Ellis, Ivan G	Madison, Wis	Roentgenology
198	Elward Joseph F	Washington D C	Roentgenology
199	Eneboe John B	San Diego Cal	Radiology
200	Enfield Charles D	Louisville Ky	Radiology
201	Erickson Lester G	South Bend Ind	Radiology
202	Ernst, Edwin C	St Louis Mo	Radiology
203	Erskine Arthur W	Cedar Rapids Ia	Radiology
204	Evans John	Baltimore, Md	Roentgenology
205	Evans William A	Detroit, Mich	Radiology
206	Eveleth Fred S	Concord N H	Roentgenology
207	Exner, Frederick B	Seattle, Wash	Radiology
208	Farmer Harry L	Cleveland O	Radiology
209	Farrell John T Jr	Philadelphia Pa	Roentgenology
210	Faust J J	Tyler, Tex	Radiology
211	Feaster O O	St Petersburg Fla	Radiology
212	Ferguson James W	Pittsburgh, Pa	Radiology
213	Feuerstein Benjamin L	Bay Shore N Y	Therapeutic Radiology
214	Finegan Solomon	New York, N Y	Roentgenology
215	Fior, Whitmer B	Baltimore Md	Roentgenology

67	Bogan, Isabel K.	Brookline, Mass	Roentgenology
68	Bogan, Mary E	Brookline, Mass	Roentgenology
69	Bogart, Franklin B	Chattanooga, Tenn	Roentgenology
70	Bonnar, James M	New Bedford, Mass	Radiology
71	Bonoff, Karl M	Los Angeles, Cal	Diagnostic Roentgenology
72	Borman, C N	Minneapolis, Minn	Radiology
73	Borzell, F F	Philadelphia, Pa	Radiology
74	Bowen, Carl B	Oakland, Cal	Roentgenology
75	Bowen, David R	Philadelphia, Pa.	Radiology
76	Bowing, Harry H	Rochester, Minn	Therapeutic Radiology
77	Boyd, James F	Providence, R I	Radiology
78	Boyes, James G	Plainfield, N J	Roentgenology
79	Bradley, Robert A	Atlantic City, N J	Radiology
80	Brams, Julius	Chicago, Ill	Radiology
81	Brandenburg, H P	Denver, Col	Radiology
82	Brenneman, R E	Meadville, Pa	Radiology
83	Bridenbaugh, J H	Billings, Mont	Radiology
84	Broeser, Henry V	Hoboken, N J	Diagnostic Roentgenology
85	Bromer, Ralph S	Bryn Mawr, Pa	Radiology
86	Brooksher, W R	Fort Smith, Ark	Radiology
87	Brouse, Ivan E	Jacksonville, Ill	Roentgenology
88	Brown, H O	Tampa, Fla	Roentgenology
89	Brown, Percy	Boston, Mass	Roentgenology
90	Brown, Samuel	Cincinnati, O	Roentgenology
91	Bruck, Samuel	Philadelphia, Pa	Radiology
92	Bryan, Lloyd	San Francisco, Cal	Roentgenology
93	Burch, Hobart A	Elmira, N Y	Radiology
94	Burcham, Thomas A	Des Moines, Ia.	Radiology
95	Burnett, H W	Dayton, O	Roentgenology
96	Butler, Nicholas G	Hartford, Conn	Radiology
97	Butler, P F	Boston, Mass	Radiology
98	Caldwell, Charles S	Pittsburgh, Pa	Roentgenology
99	Camp, John D	Rochester, Minn	Roentgenology
100	Capp, Charles S	San Antonio, Tex	Radiology
101	Carlson, Glenn D	Dallas, Tex.	Roentgenology
102	Carr, Edson W	Chicago, Ill	Diagnostic Roentgenology
103	Carter, Ray A	Los Angeles, Cal	Roentgenology
104	Carty, John R	New York, N Y	Radiology
105	Case, James T	Chicago, Ill	Radiology
106	Cathcart, John W	El Paso, Tex	Radiology
107	Challenger, Chester J	Chicago, Ill	Roentgenology
108	Chamberlain, W Edward	Philadelphia, Pa	Radiology
109	Chapman, John F	Pasadena, Cal	Roentgenology
110	Child, Arthur E	Montreal, Que.	Diagnostic Roentgenology
111	Childs, D S	Syracuse, N Y	Roentgenology
112	Childs, S B	Denver, Colo	Roentgenology
113	Chilko, A J	New Rochelle, N Y	Roentgenology
114	Christie, Arthur C	Washington, D C	Radiology
115	Ciley, Earl I L	Bellingham, Wash	Radiology
116	Claiborne, E M	New York, N Y	Radiology
117	Clark, D M	Santa Barbara, Cal	Radiology
118	Clark, James J	Atlanta, Ga	Roentgenology
119	Clark, Stanley A	South Bend, Ind	Radiology
120	Clarkson, Wright	Petersburg, Va.	Radiology
121	Cleaves, Edwin N	Boston, Mass	Diagnostic Roentgenology
122	Cleghorn, Charles D	Miami, Fla.	Radiology
123	Clement, Gage	Duluth, Minn	Radiology
124	Cleveland, W R.	Evansville, Ind	Radiology
125	Coate, J D	Oakland, Cal	Radiology
126	Coe, Fred O	Washington, D C	Radiology
127	Coffin, Whitman K	Boston, Mass	Roentgenology
128	Cohon, Carl W	Bay Shore, N Y	Diagnostic Roentgenology
129	Cole, J M	Windsor, Ont	Roentgenology
130	Cole, Lewis Gregory	New York, N Y	Roentgenology
131	Cole, Paul F	Springfield, Mo	Radiology
132	Cole, William Gregory	New York, N Y	Roentgenology
133	Coley, Stephen W	Memphis, Tenn	Roentgenology
134	Collins, E N	Cleveland, O	Diagnostic Roentgenology
135	Collins, James N	Indianapolis, Ind	Radiology
136	Collins, J J	Racine, Wis	Radiology
137	Cook, Orrin S	Sacramento, Cal	Roentgenology
138	Cook, Philip H	Worcester, Mass.	Radiology
139	Cooley, R. M	Jackson, Mich	Roentgenology
140	Coray, Q B	Salt Lake City, Utah	Roentgenology
141	Corcoran, William J	Scranton, Pa	Roentgenology

291	Harris, Clarence P	Houston, Tex	Roentgenology
292	Harris, John H	Harrisburg, Pa	Radiology
293	Harris, Milo T	Spokane, Wash	Radiology
294	Harris, T T	Omaha, Neb	Radiology
295	Harris William	New York, N Y	Therapeutic Radiology
296	Hartung, Adolph	Chicago, Ill	Roentgenology
297	Hasley, Clyde K	Detroit, Mich	Radiology
298	Hauser, Harry	Cleveland, O	Radiology
299	Hawley Sydney J	Danville, Pa	Roentgenology
300	Haworth, Wallace	Portland, Ore	Radiology
301	Hay, Percy D, Jr	Florence, S C	Radiology
302	Heacock, Charles H	Memphis, Tenn	Roentgenology
303	Healy, Thomas R	Boston, Mass	Roentgenology
304	Heatley, John E	Oklahoma City, Okla	Diagnostic Roentgenology
305	Heberding, John	Youngstown O	Radiology
306	Hefke, Hans W	Milwaukee, Wis	Radiology
307	Hendricks, Elliott M	Fort Lauderdale, Fla	Roentgenology
308	Hendrickson, Anna R	Canton, O	Roentgenology
309	Henle, Carye-Belle	Newark, N J	Roentgenology
310	Henry, Lucas S	Syracuse, N Y	Roentgenology
311	Herpel, Frederick K	West Palm Beach, Fla	Roentgenology
312	Herrman, W G	Asbury Park, N J	Radiology
313	Hess, George H	Uniontown, Pa	Roentgenology
314	Hewlman, Harry H	Long Beach, Cal	Diagnostic Roentgenology
315	Hildreth, R C	Ann Arbor, Mich	Radiology
316	Hill Harold A	San Francisco, Cal	Radiology
317	Hill Walter C	Cleveland, O	Roentgenology
318	Hilt, Lawrence M	Grand Rapids, Mich	Roentgenology
319	Hilton, James M	Klamath Falls, Ore.	Roentgenology
320	Hirsch, I Seth	New York, N Y	Radiology
321	Hodges, Fred J	Ann Arbor, Mich	Radiology
322	Hodges, Fred M	Richmond, Va	Radiology
323	Hodges, Paul C	Chicago, Ill	Radiology
324	Hoffman, William J	New York, N Y	Therapeutic Radiology
325	Holly Leland E	Muskegon, Mich	Roentgenology
326	Holmes George W	Boston, Mass	Radiology
327	Holmes Ralph W	Chillicothe, O	Roentgenology
328	Holston, Joel D	Massillon, O	Roentgenology
329	Hopkirk, C C	Santa Monica Cal	Roentgenology
330	Horrigan, Arthur J	Springfield, Mass	Roentgenology
331	Howard Campbell	New York, N Y	Radiology
332	Howard, William P	Albany N Y	Roentgenology
333	Howes, William E	Brooklyn, N Y	Radiology
334	Hubeny, M J	Chicago Ill	Roentgenology
335	Hufford Clarence E	Toledo O	Radiology
336	Hunt, Howard B	Omaha, Neb	Radiology
337	Hunt Russell R	Providence, R I	Roentgenology
338	Hunter James W, Jr	Norfolk, Va	Radiology
339	Hutton, Frederick C	Philadelphia, Pa	Roentgenology
340	Hynes William P	Washington, D C	Therapeutic Radiology
341	Ikeda, Kano	St Paul, Minn	Roentgenology
342	Illick H Earl	New York, N Y	Roentgenology
343	Imboden, Harry M	New York N Y	Roentgenology
344	Ingber, Irving S	San Francisco, Cal	Radiology
345	Irwin W A	Detroit, Mich	Radiology
346	Ivey, H B	Goldsboro N C	Radiology
347	Jaches, Leopold	New York, N Y	Radiology
348	Jackson Byron H	Scranton, Pa.	Radiology
349	Jackson, John B	Kalamazoo Mich	Roentgenology
350	Jacobs, Lewis G, Jr	San Francisco, Cal	Radiology
351	Jacox, Harold W	Pittsburgh Pa.	Radiology
352	Jarre, Hans A	Detroit, Mich	Radiology
353	Jenkinson, David L	Chicago, Ill	Roentgenology
354	Jenkinson E L	Chicago Ill	Radiology
355	Johannesson, Carl J	Walla Walla, Wash	Roentgenology
356	Johnson Brantley M	Chicago Ill	Roentgenology
357	Johnson Clayton R	Los Angeles Cal	Roentgenology
358	Johnson, Ellsworth	Winchester, Va	Roentgenology
359	Johnson Jesse B	Galveston, Tex	Roentgenology
360	Johnson Sydney E	Louisville, Ky	Radiology
361	Johnson, Vincent C	Ann Arbor, Mich	Diagnostic Roentgenology
362	Johnston Zoe Allison	Pittsburgh Pa	Radiology
363	Jones Clifford I	Cleveland O	Therapeutic Radiology
364	Jones Horace C	Detroit Mich	Roentgenology
			Radiology

216	Fisher, J W	Pittsburgh, Pa	Radiology
217	Fisher, L F	South Bend, Ind	Roentgenology
218	Flax, Nathan	Cincinnati O	Roentgenology
219	Flinn, F	Decatur, Ill	Radiology
220	Flynn, James M	Rochester, N Y	Radiology
221	Foley, Joseph M	Peoria, Ill	Roentgenology
222	Ford, Frances A	Detroit, Mich	Radiology
223	Fort, W A	Mare Island, Cal	Roentgenology
224	Fortier Lucien A	New Orleans, La.	Radiology
225	Fray, Walter W	Rochester, N Y	Radiology
226	Freedman, Eugene	Cleveland, O	Roentgenology
227	Freedman, John	Detroit, Mich	Roentgenology
228	Freid, Jacob R	New York, N Y	Radiology
229	Frere, John M	Chattanooga, Tenn	Roentgenology
230	Fricke Robert E	Rochester, Minn	Therapeutic Radiology
231	Friedland, Henry	New York, N Y	Diagnostic Roentgenology
232	Friedman, Asa B	Brooklyn, N Y	Radiology
233	Friedman, Harry F	Boston, Mass	Radiology
234	Friedman, Jacob	New York, N Y	Roentgenology
235	Friedman, Lewis J	New York, N Y	Diagnostic Roentgenology
236	Friedman, Milton	Newark, N J	Therapeutic Radiology
237	Fruchter, Joseph M	Philadelphia Pa	Radiology
238	Fugate Isaac T	Louisville, Ky	Radiology
239	Fulmer, Charles C	San Francisco, Cal	Roentgenology
240	Fulton, Huston F	Columbus O	Diagnostic Roentgenology
241	Furey, Warren W	Chicago Ill	Radiology
242	Furst, Nathan J	Newark, N J	Diagnostic Roentgenology
243	Galanti Charles P	Chicago, Ill	Roentgenology
244	Garland, L H	San Francisco, Cal	Radiology
245	Gately Tracy T	New Orleans, La	Radiology
246	Gates Russell	Minot N D	Roentgenology
247	Gelehrter Joseph	Philadelphia, Pa	Therapeutic Radiology
248	Gemmel, J H	Philipsburg, Pa	Roentgenology
249	George, Arial W	Boston, Mass	Roentgenology
250	Gerber, Isaac	Providence, R I	Radiology
251	Gershon-Cohen Jacob	Philadelphia Pa.	Radiology
252	Geyman, Milton J	Santa Barbara Cal	Diagnostic Roentgenology
253	Ghrst David M	Glendale Cal	Roentgenology
254	Gianturco, Cesare	Urbana Ill	Roentgenology
255	Giles Roy G	Temple Tex	Roentgenology
256	Gillies, Carl L	Cedar Rapids Iowa	Radiology
257	Gilmore, W M	Stratford, Ont	Radiology
258	Gingold, Joseph R	Meadville Pa	Roentgenology
259	Glover, M H	Wichita Falls Tex	Radiology
260	Goin Lowell S	Los Angeles Cal	Roentgenology
261	Golden, Ross	New York, N Y	Roentgenology
262	Goldsmith Maurice F	Pittsburgh Pa	Roentgenology
263	Goodrich, Murray E	Toledo O	Radiology
264	Goodwin Perry B	Peoria Ill	Radiology
265	Gorinkell Julius	Pittsburgh, Pa	Diagnostic Roentgenology
266	Gorsline, Clarence S	Battle Creek Mich	Roentgenology
267	Grace, Joseph M	Eloise Mich	Radiology
268	Grady, Henry W	Washington, D C	Radiology
269	Graham Ralph S	Sacramento, Cal	Radiology
270	Granger, Amédée	New Orleans La	Radiology
271	Gray, Horace D	Memphis, Tenn	Radiology
272	Greenfield Henry	Brooklyn N Y	Radiology
273	Grier George W	Pittsburgh, Pa	Radiology
274	Grimm H W	Pittsburgh Pa	Therapeutic Radiology
275	Groeschel, L B	New York, N Y	Radiology
276	Groh, Jean A	Cleveland O	Roentgenology
277	Groover, Thomas A	Washington D C	Radiology
278	Habbe J Edwin	Milwaukee, Wis	Roentgenology
279	Hackney, Urban P	Dallas Tex	Radiology
280	Hadley, Lee A	Syracuse N Y	Roentgenology
281	Hall, E Walter	Detroit Mich	Radiology
282	Hall, Wendell C	Philadelphia, Pa	Radiology
283	Hamilton, W S	San Antonio Tex	Diagnostic Roentgenology
284	Hampton, A O	Boston Mass	Radiology
285	Hankins, John L	Johnson City Tenn	Roentgenology
286	Hansen Cyrus O	Minneapolis Minn	Radiology
287	Harding D B	Lexington Ky	Radiology
288	Hardy Clyde C	Omaha Neb	Diagnostic Roentgenology
289	Hare Hugh F	Boston Mass	Radiology
290	Harrington B D	Tacoma Wash	Radiology

438	Loud, Norman W	New Britain, Conn	Diagnostic Roentgenology
439	Lucas Charles D	Charlotte, N C	Therapeutic Radiology
440	Lucinian, Joseph H.	Miami, Fla	Roentgenology
441	Lutz, Jeremiah F	York Pa	Roentgenology
442	MacColl D R	Los Angeles, Cal	Roentgenology
443	MacComb W S	New York, N Y	Therapeutic Radiology
444	McCarthy Humphrey L	Boston, Mass	Roentgenology
445	McCarthy Justin E	Cincinnati, O	Radiology
446	McCaw William W	Washington, D C	Radiology
447	McClanahan Charles W	West Los Angeles, Cal	Radiology
448	McClelland Donald C	Lafayette, Ind	Radiology
449	McClure C C	Nashville Tenn	Radiology
450	McCormick, Arthur F	Du Bois, Pa	Roentgenology
451	McCormick H G	Laurel Miss	Roentgenology
452	McCormick William M	Du Bois Pa	Roentgenology
453	McCullough, John F	Pittsburgh Pa	Radiology
454	McDeed Winfield G	Houston Tex	Roentgenology
455	McDermott Joseph L	Kansas City Mo	Radiology
456	McElfatrick, George C	Wilmington Del	Roentgenology
457	McEuen Harry B	Jacksonville, Fla	Radiology
458	McGaughey H D	Joplin Mo	Radiology
459	McGee, Harry H	Savannah, Ga	Roentgenology
460	McGhee William H	Fresno Cal	Roentgenology
461	McGlothlin, Arthur B	St Joseph, Mo	Radiology
462	McGuffin, W Herbert	Calgary Alberta	Radiology
463	McHenry, Rupert K	Houston, Tex	Roentgenology
464	McIntosh Harriet C	New York, N Y	Roentgenology
465	McKinney, Joseph T	Roanoke Va	Roentgenology
466	McNabb Athol M	Ottawa, Ont	Roentgenology
467	McNamee Edgar P	Cleveland, O	Diagnostic Roentgenology
468	McNutt John R	Duluth Minn	Radiology
469	McPeak, Clarence N	Fitchburg, Mass	Roentgenology
470	McPeak Edgar M	Washington D C	Radiology
471	Macmillan A S	Boston Mass	Diagnostic Roentgenology
472	Magruder L Freeland	Norfolk Va	Radiology
473	Mahrer Herbert A	Cleveland O	Roentgenology
474	Maier, Roe J	Chicago Ill	Radiology
475	Malcolmson Patrick H	Edmonton Alberta	Radiology
476	Malone Leander A	Terre Haute, Ind	Radiology
477	Mandeville Frederick B	Richmond, Va	Roentgenology
*478	Manges Willis F	Philadelphia Pa	Radiology
479	Marchbanks S S	Chattanooga, Tenn	Radiology
480	Marks Joseph H	Fall River, Mass	Roentgenology
481	Marquis, W James	Newark N J	Roentgenology
482	Martin Charles L	Dallas Tex	Radiology
483	Martin, James M	Dallas, Tex	Radiology
484	Martin W C	Louisville, Ky	Roentgenology
485	Mason Claude H	El Paso Tex	Diagnostic Roentgenology
486	Masterson John J	Brooklyn, N Y	Roentgenology
487	Matlack, James A	Longmont Colo	Diagnostic Roentgenology
488	Mattick Walter L	Buffalo, N Y	Radiology
489	Maver William W	Jersey City, N J	Roentgenology
490	Mawhinney, Harvey N	Pittsburgh Pa	Diagnostic Roentgenology
491	May Ernst A	East Orange, N J	Radiology
492	May, Raymond V	Cleveland, O	Radiology
493	May Robert J	Cleveland, O	Radiology
494	Mayfield Claud	Long Beach, Cal	Diagnostic Roentgenology
495	Meadows James A	Birmingham Ala	Radiology
496	Means Hugh J	Columbus O	Radiology
497	Medelman, John P	St Paul Minn	Roentgenology
498	Meland Orville N	Los Angeles Cal	Therapeutic Radiology
499	Meltzer Samuel L	Portsmouth, O	Diagnostic Roentgenology
500	Mendelson Lmanuel	Brooklyn N Y	Roentgenology
501	Menees Thomas O	Grand Rapids, Mich	Radiology
502	Menville Leon J	New Orleans La	Radiology
503	Murchant Albert K	Philadelphia Pa	Radiology
504	Merrill E Forrest	New York N Y	Roentgenology
505	Merritt, F A	Washington, D C	Radiology
506	Mesrow Sidney D	Chicago Ill	Roentgenology
507	Meter Edward G	Reading Pa	Radiology
508	Meyer Keith T	Evansville Ind	Roentgenology
509	Meyer William H	New York N Y	Radiology
510	Miles, John M	New Orleans La	Diagnostic Roentgenology

365	Jones, William A	Kingston, Ont	Radiology
366	Judson, Herbert A	Los Angeles, Cal	Roentgenology
367	Judy, William S	Greenville, S C	Radiology
368	Kabakjian Armen E	Lancaster, Pa	Radiology
369	Kahn Max	Baltimore, Md	Roentgenology
370	Kalbfleisch, William K	Wheeling, W Va	Roentgenology
371	Kann, U S	Binghamton, N Y	Radiology
372	Kaplan, Ira I	New York N Y	Therapeutic Radiology
373	Kaplan, Morris	New York, N Y	Diagnostic Roentgenology
374	Kapo, Peter J	Mahanoy City Pa	Radiology
375	Kasabach, Haig H	New York, N Y	Radiology
376	Keichline John M	Huntingdon, Pa	Radiology
377	Keith, David Y	Louisville, Ky	Radiology
378	Kelley, Jacob S	Providence, R I	Roentgenology
379	Kellogg, John O	San Diego, Cal	Radiology
380	Kelly, James F	Omaha Neb	Radiology
381	Kenning, John C	Detroit, Mich	Radiology
382	Kerby, James P	Salt Lake City Utah	Roentgenology
383	Kerr, H Dabney	Iowa City, Ia	Radiology
384	Kesmodel Karl F	Birmingham, Ala	Radiology
385	Kidder, Frank W	Los Angeles Cal	Diagnostic Roentgenology
386	King J Cash	Memphis Tenn	Radiology
387	Kinney Lyell C	San Diego Cal	Radiology
388	Kirkland, A Stanley	St John, N B	Roentgenology
389	Kirklin B R	Rochester, Minn	Radiology
390	Klapproth, Herman	Halstead Kans	Roentgenology
391	Klein William	New Brunswick, N J	Radiology
392	Koiransky, Gennady H	Long Island City, N Y	Diagnostic Roentgenology
393	Kolvoord, Theodore	Battle Creek, Mich	Diagnostic Roentgenology
394	Kornblum, Karl	Philadelphia, Pa	Radiology
395	Kraft Ernest	New York, N Y	Roentgenology
396	Kuegle, F H	Janesville, Wis	Roentgenology
397	Kugler, Joseph C	Jackson Mich	Roentgenology
398	Kuhlman, Fred Y	Springfield Ill	Roentgenology
399	Lafferty, R H	Charlotte N C	Radiology
400	Landau, George M	Chicago Ill	Roentgenology
401	Landes W L S	York Pa	Roentgenology
402	Langan Paul C	Akron O	Diagnostic Roentgenology
403	Lange, Sidney	Cincinnati O	Radiology
*404	Langer Heinz	Pittsburgh Pa	Therapeutic Radiology
405	Lanman, Everett L	Battle Creek Mich	Roentgenology
406	Lape C Pearley	Buffalo N Y	Diagnostic Roentgenology
407	Larkey, Charles J	Bayonne N J	Diagnostic Roentgenology
408	Lattman Isidore	Washington D C	Radiology
409	Law, F M	New York N Y	Diagnostic Roentgenology
410	Lawrence W S	Memphis Tenn	Radiology
411	Lawson John D	Sacramento Cal	Radiology
412	Leddy E T	Rochester, Minn	Radiology
413	Ledoux Alfred C	Evanston Ill	Radiology
414	Leef Edward	San Francisco Cal	Radiology
415	LeFevre Walter I	Cleveland O	Roentgenology
416	Lehman J S	Philadelphia, Pa	Radiology
417	Leibert, Harry F	Bethlehem Pa	Roentgenology
418	Lenz Maurice	New York N Y	Therapeutic Radiology
419	Leonard Ralph D	Boston Mass	Roentgenology
420	Leucutia T	Detroit Mich	Radiology
421	Levene George	Boston Mass	Roentgenology
422	Levi Irwin P	Anniston Ala	Roentgenology
423	Levin Alfred G	Miami Fla	Radiology
424	Le Vine, David	El Dorado Ark	Diagnostic Roentgenology
425	Levine Samuel	Philadelphia, Pa	Radiology
426	Levitin Joseph	San Francisco Cal	Radiology
427	Levyn, Lester	Buffalo N Y	Diagnostic Roentgenology
428	Lewis Raymond W	New York N Y	Diagnostic Roentgenology
429	Lhevine Morris B	Tulsa Okla	Roentgenology
430	Lieberman, Charles	Montreal Que.	Roentgenology
431	Liljedahl Elmer N	Los Angeles Cal	Roentgenology
432	Lingeman Leslie R	Rochester N Y	Roentgenology
433	Lipschultz Oscar	Minneapolis Minn	Roentgenology
434	Litschgi Joseph J	Chicago Ill	Roentgenology
435	Littig L V	Madison Wis	Radiology
436	Lochry, Ralph L	Indianapolis Ind	Roentgenology
437	Lockwood Ira H	Kansas City Mo	Radiology

582	Peterson, George E	Waukesha, Wis	Radiology
583	Peterson, V L	Charleston W Va	Radiology
584	Petrie, E A	St Johns, N B	Roentgenology
585	Pettut, Roswell T	Ottawa Ill	Therapeutic Radiology
586	Pfahler, G E	Philadelphia, Pa	Radiology
587	Philips, Herman B	New York, N Y	Radiology
588	Phillips, Clyde C	Charlotte, N C	Radiology
589	Pierce, Harold J	Terre Haute, Ind	Radiology
590	Pierston, John W	Baltimore, Md	Radiology
591	Pindell, Merl L	Los Angeles, Cal	Diagnostic Roentgenology
592	Pines John A	Orlando, Fla	Therapeutic Roentgenology
593	Pirie A H	Montreal Que	Radiology
594	Pitts, Thomas A	Columbia, S C	Roentgenology
*595	Podlasky, Harry B	Milwaukee Wis	Roentgenology
596	Pohle, E A	Madison Wis	Therapeutic Radiology
597	Pomeranz Maurice M	New York N Y	Radiology
598	Pomeranz, Raphael	Newark, N J	Roentgenology
599	Pomeroy, Lawrence A	Cleveland, O	Radium Therapy
600	Popoff, Constantine	Haverhill Mass	Diagnostic Roentgenology
601	Popp, Walter C	Rochester, Minn	Therapeutic Radiology
602	Porter, Horace W	Jackson, Mich	Radiology
603	Portmann U V	Cleveland, O	Radiology
604	Post Joseph W	Philadelphia, Pa	Diagnostic Roentgenology
605	Potter Carlton F	Syracuse N Y	Roentgenology
606	Potter, Hollis E	Chicago, Ill	Roentgenology
607	Potter, Roy P	Marshfield Wis	Roentgenology
608	Pound Robert E	New York N Y	Roentgenology
609	Powell E V	Temple, Texas	Radiology
610	Powers, Martin T	Utica, N Y	Diagnostic Roentgenology
611	Powers, Richard T	Springfield, Mass	Radiology
612	Powers Robert A	Palo Alto Cal	Radiology
613	Price, R J	Dayton, O	Radiology
614	Prouty J V	Terre Haute Ind	Radiology
615	Putts, B Swayne	erie Pa	Roentgenology
616	Quick, Douglas	New York N Y	Therapeutic Radiology
617	Quigley, D T	Omaha Neb	Radium Therapy
618	Quimby, A Judson	New York N Y	Roentgenology
619	Quiney, James J	Easton Pa	Radiology
620	Quinlan Catherine M	Santa Rosa Cal	Roentgenology
621	Raap Gerard	Miami Fla	Radiology
622	Radding, Moses B	Elizabeth, N J	Diagnostic Roentgenology
623	Rathbone Ralph R	Washington D C	Radiology
624	Rauschenbach Charles W	Hammond, Ind	Roentgenology
625	Ravold Henry J	St Joseph Mo	Radiology
626	Ray William B G	Pittsburgh Pa	Roentgenology
627	Reaves Hugh G	Knoxville, Tenn	Roentgenology
628	Reed, Charles B	Newburgh N Y	Roentgenology
629	Reeves Robert J	Durham N C	Radiology
630	Reiley, William E	Clearfield Pa	Radiology
631	Remekc Harold G	Cincinnati, O	Roentgenology
632	Reutter George S	East Orange N J	Radiology
633	Remer, John	New York N Y	Therapeutic Roentgenology
634	Rendich Richard A	Brooklyn N Y	Roentgenology
635	Reynolds Lawrence	Detroit Mich	Radiology
636	Rhinehart, Darmon A	Little Rock, Ark	Roentgenology
637	Rhudy Booker E	Greensboro N C	Roentgenology
638	Rice Frank M	San Francisco Cal	Roentgenology
639	Richards Charles M	San Jose Cal	Radiology
640	Rigler Leo G	Minneapolis, Minn	Radiology
641	Ritvo Max	Boston, Mass	Radiology
642	Ritzman Allen Z	Harrisburg Pa	Roentgenology
643	Roberts Douglas J	Hartford Conn	Radiology
644	Robin Nathaniel H	Hempstead N Y	Roentgenology
645	Robin Percival A	Hempstead N Y	Roentgenology
646	Robins Samuel A	Boston Mass	Roentgenology
647	Robinson G Allen	New York, N Y	Therapeutic Radiology
*648	Robinson Ralph V	Pittsburgh Pa	Roentgenology
649	Robinson Walter W	Memphis Tenn	Roentgenology
650	Rodenbaugh Frederick H	San Francisco Cal	Radiology
651	Rodgers Floyd D	Columbia S C	Radiology
652	Rodick J C	New Orleans La	Roentgenology
653	Rodriguez Juan	Fort Wayne Ind	Radiology

511	Milkman, Louis A	Scranton, Pa	Roentgenology
512	Miller, Harry A	Baltimore, Md	Radiology
513	Millwee, Robert H	Dallas, Tex	Radiology
514	Ming, Charles M	Oklmulgee, Okla	Radiology
515	Minor, Edward G	Detroit, Mich	Diagnostic Roentgenology
516	Moffatt, F J	Medford, Ore	Diagnostic Roentgenology
517	Moloney, Albert M	Boston, Mass	Roentgenology
518	Moore, Alexander B	Washington, D C	Radiology
519	Moore, Claude	Washington, D C	Radiology
520	Moore, Daniel M	Monroe, La	Roentgenology
521	Moore, John J	San Francisco, Cal	Radiology
522	Moore, Paul D	Muncie, Ind	Radiology
523	Moore, Sherwood	St Louis, Mo	Radiology
524	Moore, Vernon M	Grand Rapids, Mich	Radiology
525	Morrison, Murray C	London, Ont	Radiology
526	Morrison, Sidney L	Boston, Mass	Roentgenology
527	Morse, Russell W	Minneapolis, Minn	Roentgenology
528	Morton, S A	Milwaukee, Wis	Radiology
529	Moxness, Bennie A	Northampton, Mass	Diagnostic Roentgenology
530	Mueller, W K	St Louis, Mo	Diagnostic Roentgenology
531	Mulligan, Peter B	Ashland, Pa	Roentgenology
532	Murphy, G W	Asheville, N C	Roentgenology
533	Murphy, John T	Toledo, O	Radiology
534	Myers, Ralph E	Oklahoma City, Okla	Radiology
535	Naslund, Ames W	St Paul, Minn	Roentgenology
536	Nathanson, Louis	Brooklyn, N Y	Radiology
537	Nelson, Peter A	Chicago, Ill	Therapeutic Radiology
538	Nessa, N J	Sioux Falls, S D	Roentgenology
539	Newcomet, William S	Philadelphia, Pa	Radiology
540	Newell, Robert R	San Francisco, Cal	Radiology
541	Nichols, B H	Cleveland, O	Radiology
542	Nichols, Harold E	Seattle, Wash	Diagnostic Roentgenology
543	Nordin, Gustaf T	Minneapolis, Minn	Radiology
544	O'Bannon, R P	Fort Worth, Tex	Radiology
545	O'Boyle, Cyril P	Philadelphia, Pa	Diagnostic Roentgenology
546	O'Brien, Frederick W	Boston, Mass	Radiology
547	O'Connell, Andrew E	Worcester, Mass	Roentgenology
548	O'Neill, John R	San Francisco, Cal	Roentgenology
549	Oechsli, Waldo R	Olive View, Cal	Diagnostic Roentgenology
550	Ogden, Ralph T	Hartford, Conn	Radiology
551	Olin, Harry	Chicago, Ill	Roentgenology
552	Orndoff, B H	Chicago, Ill	Radiology
553	Orr, Clifford R	Buffalo, N Y	Radiology
554	Osmond, John D	Cleveland, O	Roentgenology
555	Osmond, Leslie H	Pittsburgh, Pa	Radiology
556	Ossip, Abraham	New York, N Y	Diagnostic Roentgenology
557	Ostrum, Herman W	Philadelphia, Pa	Roentgenology
558	Ourian, Adam K	New York, N Y	Diagnostic Roentgenology
559	Overgaard, Anders P	Omaha, Neb	Radiology
560	Owen, Arthur K	Topeka, Kans	Roentgenology
561	Owen, Colin C	San Bernardino, Cal	Roentgenology
*562	Paine, Robert	Memphis, Tenn	Radiology
563	Pallen, Conde deS	Rochelle Park, N J	Therapeutic Radiology
564	Palmer, Dorwin L	Portland, Ore	Radiology
565	Pancoast, Henry K	Philadelphia, Pa	Radiology
566	Parker, Carl H	Pasadena, Cal	Roentgenology
567	Parmelee, B M	Bridgeport, Conn	Radiology
*568	Parry, Leo D	Easton, Pa	Radiology
569	Paul, Lester W	Madison, Wis	Diagnostic Roentgenology
570	Pawling, Jesse R	Watertown, N Y	Diagnostic Roentgenology
571	Peden, Joseph C	St Louis, Mo	Roentgenology
572	Peirce, Carleton B	Ann Arbor, Mich	Radiology
573	Pendergrass, E P	Philadelphia, Pa	Radiology
574	Pendergrass, Robert C	Americus, Ga	Roentgenology
575	Percival, Milton F	Philadelphia, Pa	Radiology
576	Perkins, Charles W	Norwalk, Conn	Roentgenology
577	Perlberg, Harry J	Jersey City, N J	Diagnostic Roentgenology
578	Perley, Arthur E	Waterloo, Ia	Radiology
579	Perry, Gentz	Evanston, Ill	Radiology
580	Peters, Chester M	Canton, O	Radiology
581	Peterson, Charles H	Roanoke, Va	Roentgenology

582	Peterson, George E	Waukesha, Wis	Radiology
583	Peterson, V L	Charleston, W Va	Radiology
584	Petrie, E A	St Johns, N B	Roentgenology
585	Pettit, Roswell T	Ottawa, Ill	Therapeutic Radiology
586	Pfahler, G E	Philadelphia, Pa	Radiology
587	Philips, Herman B	New York, N Y	Radiology
588	Phillips Clyde C	Charlotte, N C	Radiology
589	Pierce, Harold J	Terre Haute, Ind	Radiology
590	Pierson, John W	Baltimore, Md	Radiology
591	Pindell, Merl L	Los Angeles, Cal	Diagnostic Roentgenology
592	Pines, John A	Orlando, Fla	Therapeutic Roentgenology
593	Pirie, A H	Montreal, Que	Radiology
594	Pitts, Thomas A	Columbia, S C	Roentgenology
*595	Podlasky, Harry B	Milwaukee, Wis	Roentgenology
596	Pohle, E A	Madison, Wis	Therapeutic Radiology
597	Pomeranz, Maurice M	New York, N Y	Radiology
598	Pomeranz, Raphael	Newark, N J	Roentgenology
599	Pomeroy, Lawrence A	Cleveland O	Radium Therapy
600	Popoff, Constantine	Haverhill Mass	Diagnostic Roentgenology
601	Popp, Walter C	Rochester, Minn	Therapeutic Radiology
602	Porter, Horace W	Jackson, Mich	Radiology
603	Portmann, U V	Cleveland, O	Radiology
604	Post Joseph W	Philadelphia, Pa	Diagnostic Roentgenology
605	Potter, Carlton F	Syracuse, N Y	Roentgenology
606	Potter, Hollis E	Chicago Ill	Roentgenology
607	Potter, Roy P	Marshfield, Wis	Roentgenology
608	Pound Robert E	New York N Y	Roentgenology
609	Powell E V	Temple Texas	Radiology
610	Powers, Martin T	Utica, N Y	Diagnostic Roentgenology
611	Powers, Richard T	Springfield, Mass	Radiology
612	Powers Robert A	Palo Alto Cal	Radiology
613	Price, R J	Dayton O	Radiology
614	Prouty, J V	Terre Haute Ind	Radiology
615	Putts, B Swayne	Erie Pa	Roentgenology
616	Quick, Douglas	New York, N Y	Therapeutic Radiology
617	Quigley, D T	Omaha, Neb	Radium Therapy
618	Qumby, A Judson	New York, N Y	Roentgenology
619	Quiney, James J	Easton, Pa	Radiology
620	Quinlan, Catherine M	Santa Rosa, Cal	Roentgenology
621	Raap Gerard	Miami, Fla	Radiology
622	Radding, Moses B	Elizabeth, N J	Diagnostic Roentgenology
623	Rathbone, Ralph R	Washington, D C	Radiology
624	Rauschenbach, Charles W	Hammond, Ind	Roentgenology
625	Ravold Henry J	St Joseph, Mo	Radiology
626	Ray, William B G	Pittsburgh, Pa	Roentgenology
627	Reaves, Hugh G	Knoxville, Tenn	Roentgenology
628	Reed, Charles B	Newburgh, N Y	Roentgenology
629	Reeves, Robert J	Durham, N C	Radiology
630	Reiley William E	Clearfield, Pa	Radiology
631	Reincke Harold G	Cincinnati, O	Roentgenology
632	Reitter, George S	East Orange, N J	Radiology
633	Remer, John	New York, N Y	Therapeutic Roentgenology
634	Rendich Richard A	Brooklyn N Y	Roentgenology
635	Reynolds Lawrence	Detroit, Mich	Radiology
636	Rhinehart, Darmon A	Little Rock, Ark	Roentgenology
637	Rhudy Booker E	Greensboro, N C	Roentgenology
638	Rice Frank M	San Francisco Cal	Roentgenology
639	Richards, Charles M	San Jose Cal	Radiology
640	Rigler Leo G	Minneapolis, Minn	Radiology
641	Ritvo Max	Boston, Mass	Radiology
642	Ritzman Allen Z	Harrisburg Pa	Roentgenology
643	Roberts Douglas J	Hartford, Conn	Radiology
644	Robin Nathaniel H	Hempstead N Y	Roentgenology
645	Robin Percival A	Hempstead, N Y	Roentgenology
646	Robins Samuel A	Boston, Mass	Roentgenology
647	Robinson G Allen	New York, N Y	Therapeutic Radiology
*648	Robinson Ralph V	Pittsburgh Pa	Roentgenology
649	Robinson Walter W	Memphis Tenn	Roentgenology
650	Rodenbaugh Frederick H	San Francisco Cal	Radiology
651	Rodgers Floyd D	Columbia S C	Radiology
652	Rodick J C	New Orleans, La	Roentgenology
653	Rodriguez Juan	Fort Wayne, Ind	Radiology

*654	Roland, Marion M	Oklahoma City Okla	Therapeutic Radiology
655	Rork, Lee W	Hastings Neb	Roentgenology
656	Rose Cassie B	Chicago Ill	Radiology
657	Rosenbaum George	Philadelphia, Pa	Diagnostic Roentgenology
658	Rosh Rieva	New York N Y	Therapeutic Radiology
659	Rousseau J P	Winston-Salem N C	Radiology
660	Rowe, Edward W	Lincoln, Neb	Radiology
661	Rowell Edward E	Stamford Conn	Roentgenology
662	Rubinfeld Sidney	New York, N Y	Therapeutic Radiology
663	Rubert, Samuel R	Chicago Ill	Roentgenology
664	Rude Joe C	New York, N Y	Radiology
665	Rudisill Hillyer, Jr	Charleston S C	Radiology
666	Ruggles, Howard E	San Francisco Cal	Roentgenology
667	Rulison Foster C	Syracuse N Y	Roentgenology
668	Rutledge, Clifford P	Shreveport, La	Radiology
669	Rypins, Edwin L	Bloomington, Ill	Radiology
670	Samuel Ernest C	New Orleans La	Roentgenology
671	Sanderson Stevens S	Detroit Mich	Radiology
672	Sante, L R	St Louis, Mo	Radiology
673	Sargent, William H	Oakland, Cal	Radiology
674	Schenck Samuel George	Brooklyn N Y	Radiology
675	Schimmelpfennig R D	Montclair, N J	Roentgenology
676	Schmidt, Ernst A	Denver, Colo	Radiology
677	Schmitz, Henry	Chicago Ill	Therapeutic Radiology
678	Schnack, A G	Honolulu Hawaii	Radiology
679	Schoebelen Paul C	St Louis, Mo	Roentgenology
680	Schons, Edward	St. Paul, Minn	Radiology
681	Schumacher, F L	Pittsburgh Pa	Radiology
682	Schwartz Charles W	New York, N Y	Roentgenology
683	Schwartz Irving	New York N Y	Diagnostic Roentgenology
684	Scott, Clifton R.	New Haven Conn	Roentgenology
685	Scott, Wilhelmina S	Lancaster Pa	Radiology
686	Seeds Asa E	Spokane Wash	Radiology
687	Shapiro Abraham V	Brooklyn N Y	Diagnostic Roentgenology
688	Shapiro, William M	Toledo O	Radiology
689	Sharpe, A Maxwell	Chester, Pa	Roentgenology
690	Shaw W McL	Jacksonville, Fla	Roentgenology
691	Shebesta, Emil M	Detroit, Mich.	Radiology
692	Sheldon, Francis B	Stockton Cal	Radiology
693	Sheridan, William M	Spartanburg S C	Radiology
*694	Sherman, Herbert deG	White Plains N Y	Diagnostic Roentgenology
695	Sherrick Earl C	Connellsville Pa	Diagnostic Roentgenology
696	Shifflett E Lee	Louisville Ky	Roentgenology
697	Shore, O J	Detroit Mich	Diagnostic Roentgenology
698	Shoulders H S	Nashville Tenn	Radiology
699	Shulman Simon	Far Rockaway N Y	Roentgenology
700	Sichler, Harper G	Lafayette Ind	Radiology
701	Sickels Thomas N	Watertown N Y	Roentgenology
702	Siefert, Alfred C	Oakland Cal	Radiology
703	Sigman, Frederick G	Salisbury, N C	Roentgenology
704	Sims George P	Columbus O	Therapeutic Radiology
705	Skinner, Edward H	Kansas City Mo	Radiology
706	Skomp C E	Denver Colo	Diagnostic Roentgenology
707	Smedal M I	Boston Mass	Radiology
708	Smith, Arthur B	La Jolla Cal	Diagnostic Roentgenology
709	Smith B B	Buffalo N Y	Diagnostic Roentgenology
710	Smith Jerome H	San Angelo Tex	Radiology
711	Smith, Lester A	Indianapolis Ind	Radiology
712	Smith Richard L	Grand Rapids Mich	Radiology
713	Smith R Manges	Philadelphia Pa	Roentgenology
714	Smith Roscoe L	Lincoln, Neb	Radiology
715	Smyth, Thomas L	Allentown Pa	Roentgenology
716	Snead Lawrence O	Richmond Va	Roentgenology
717	Snow Henry	Dayton O	Radiology
718	Snow William	New York N Y	Roentgenology
719	Snure, Henry	Los Angeles Cal	Roentgenology
720	Soland Albert	Los Angeles Cal	Radiology
721	Solis Cohen Leon	Philadelphia Pa	Radiology
722	Sosman, M C	Boston Mass	Roentgenology
723	Soule Arthur B Jr	Burlington Vt	Radiology
724	Spackman Edgar W	Philadelphia Pa	Radiology
725	Spangler Davis	Dallas Tex	Roentgenology
726	Spencer, Hunter B	Lynchburg Va	

727	Spencer, Jack	Boston, Mass	Radiology
728	Spillman, Ramsay	New York, N Y	Diagnostic Roentgenology
729	Spilman, Harold A	Ottumwa, Ia	Roentgenology
730	Spinzig, Edgar W	St Louis, Mo	Radiology
731	Sproull, John	Haverhill, Mass	Roentgenology
732	Squire, Fay H	Chicago, Ill	Roentgenology
733	Stafford, Owen R	Los Angeles, Cal	Therapeutic Roentgenology
734	Stall, Arthur H	Akron, O	Radiology
735	Stammel, Charles A	Fort Benning, Ga	Diagnostic Roentgenology
736	Starks, Dorothy J	Palo Alto, Cal	Radiology
737	Startz, Irving S	Elmhurst, N Y	Roentgenology
738	Stayton, Chester A	Indianapolis, Ind	Roentgenology
739	Stecher, William R	Darby Pa	Radiology
740	Steel David	Cleveland, O	Roentgenology
741	Steiner, Joseph M	New York, N Y	Roentgenology
742	Stephenson, F B	Denver, Colo	Radiology
743	Stevens R H	Detroit, Mich	Radiology
744	Stewart, Harry M	Johnstown Pa	Radiology
745	Stewart Wendell	East St Louis Ill	Diagnostic Roentgenology
746	Stewart William H	New York, N Y	Roentgenology
747	Stone, Robert S	San Francisco, Cal	Roentgenology
748	Strauss, Abraham	Cleveland, O	Radium Therapy
749	Stuart Leon H	Tulsa Okla	Roentgenology
750	Sussman, Marcy L	New York N Y	Radiology
751	Sutherland Charles G	Rochester, Minn	Diagnostic Roentgenology
752	Swenson Paul C	New York, N Y	Roentgenology
753	Swope, Opie W	Wichita, Kans	Radiology
754	Sycamore, Leslie K	Hanover, N H	Radiology
755	Tabb, John L, Jr	Richmond Va	Roentgenology
756	Taft Robert B	Charleston, S C	Radiology
757	Talley Daniel D, Jr	Richmond Va	Roentgenology
758	Tamarkin, Saul J	Youngstown, O	Radiology
759	Taormina Louis J	Brooklyn N Y	Diagnostic Roentgenology
760	Taylor Clifford C	Indianapolis Ind	Radiology
761	Taylor Henry K	New York N Y	Diagnostic Roentgenology
762	Taylor Raymond G	Los Angeles, Cal	Radiology
763	Taylor Richard T	Los Angeles, Cal	Radiology
764	Tettelbaum Meyer D	New Orleans, La	Roentgenology
765	Templeton Frederic E	Chicago Ill	Radiology
766	Thomas M A	Cleveland O	Radiology
767	Thompson Harold B	Seattle Wash	Radiology
768	Thursson Paul F	Riverside Cal	Roentgenology
769	Tice Galen M	Kansas City Kans	Radiology
770	Tichy L S	Chicago Ill	Roentgenology
771	Titterington Paul F	St Louis Mo	Roentgenology
772	Treves Norman	New York N Y	Therapeutic Radiology
773	Troje Oscar R	Fairfield Ala	Radiology
774	Trostler Isador S	Chicago Ill	Radiology
775	Troup Ralph L	Green Bay Wis	Radiology
776	Troxell William C	Allentown, Pa	Roentgenology
777	Tuggle Allen	New York N Y	Radiology
778	Tyler Albert F	Omaha Neb	Radiology
779	Ude Walter H	Minneapolis Minn	Roentgenology
780	Ulbrich Henry L	Detroit Mich	Roentgenology
781	Ullmann Henry J	Santa Barbara Cal	Radiology
782	Unfug George A	Pueblo Colo	Radiology
783	Unger Arthur S	New York, N Y	Roentgenology
784	Upton Wilbur O	Battle Creek, Mich	Radiology
785	Van Allen Harvey W	Springfield Mass	Radiology
786	Van Buskirk Edmund M	Fort Wayne Ind	Roentgenology
787	Van Nuy's Roscoe G	Berkeley Cal	Radiology
788	Van Winkle LeRoy P	Brooklyn N Y	Diagnostic Roentgenology
789	Vastine Jacob H	Philadelphia Pa	Radiology
790	Velkoff Metodi	Fort Wayne Ind	Roentgenology
791	Varden C Edgar	Kansas City Mo	Radiology
792	Vogt Edward C	Boston Mass	Roentgenology
793	Voke Edward L	Akron O	Roentgenology
794	Volderauer John C	Chicago Ill	Diagnostic Roentgenology
795	Voltz Albert L	Richmond Hill N Y	Radiology
796	von Poswick Gisela	Scranton Pa	Roentgenology
797	Wachowski T J	Chicago Ill	Roentgenology
798	Walker Howard M	Fort Worth Tex	Radiology
799	Wallace K K	Norfolk Va	Radiology

800	Walton, Henry J	Baltimore, Md	Radiology
801	Warden, Marine R	Albuquerque N M	Roentgenology
802	Warfield, Chester H	Wichita Kans	Roentgenology
803	Warren Alva H	Malden Mass	Diagnostic Roentgenology
804	Wasch, Milton G	Brooklyn N Y	Radiology
805	Wasson, W W	Denver, Colo	Radiology
806	Waters Charles A	Baltimore Md	Radiology
807	Watkins W Warner	Phoenix, Ariz	Radiology
808	Weaver Clarence E	Detroit, Mich	Roentgenology
*809	Webb, James A H	Wichita, Kans	Roentgenology
810	Weber, Harry M	Rochester Minn	Roentgenology
811	Weeks Paul R	Denver, Colo	Radiology
812	Weiskotten, W Otto	San Diego, Cal	Roentgenology
813	Weitzner Imre	New York N Y	Diagnostic Roentgenology
814	Weitzner, Samuel F	New York N Y	Diagnostic Roentgenology
815	Wentworth A J	Mankato Minn	Radiology
816	Wescott William C	Atlantic City, N J	Radiology
817	West James H	Cleveland, O	Radiology
818	West, Theodore S	Port Chester N Y	Roentgenology
819	Wheatley Frank E	Boston, Mass	Radiology
820	Wheatley, Louis F	New Haven, Conn	Roentgenology
821	Whelan, Charles	Boston, Mass	Radiology
822	Whitehead Lawther J	Richmond Va	Roentgenology
823	Whitlock, Simon B	Norfolk Va	Roentgenology
824	Widmann, B P	Philadelphia Pa	Radiology
825	Wigby, Palmer E	Dallas Tex	Radiology
826	Wilcox, Clark A	Wichita Falls, Tex	Radiology
827	Williams, Arthur J	San Francisco Cal	Radiology
*828	Williams, Francis H	Boston Mass	Radiology
829	Williams, Lester J	Baton Rouge, La	Radiology
830	Williams P A	Hempstead, N Y	Roentgenology
831	Willy, Ralph G	Chicago, Ill	Roentgenology
832	Wilson, Hugh M	New Haven Conn	Roentgenology
833	Wilson James E	Clarksburg W Va	Diagnostic Roentgenology
834	Wilson John S	Monticello, Ark	Therapeutic Radiology
835	Wilson, R T	Austin, Tex	Roentgenology
836	Wilson, Stanley A	Lewiston, Me	Roentgenology
837	Winchell A Vaughn	Rochester N Y	Therapeutic Radiology
838	Wissler J E	Washington D C	Radiology
839	Withers Sanford M	Denver Colo	Therapeutic Radiology
840	Witwer E R	Detroit, Mich	Radiology
841	Woolford, Joseph S	Eureka Cal	Radiology
842	Wright, Cecil S	Indianapolis, Ind	Radiology
843	Wurster Lloyd E	Williamsport, Pa	Roentgenology
844	Young Barton R	Philadelphia, Pa	Radiology
845	Young, James L R	New York, N Y	Therapeutic Radiology
846	Zink, Oscar C	St Louis Mo	Radiology
847	Zulick J Donald	Philadelphia Pa	Roentgenology

* Deceased

In addition to the above list there are a number who have passed part of the examination and will appear again for examination in other branches

There will be two examinations conducted by the Board during 1937, the first to be held in Atlantic City, June 4, 5, and 6, and the second in Chicago, Sept. 10, 11, and 12 Those who contemplate appearing before the Board at either of these meetings should have their

applications in the Secretary's office at least three months in advance of the meeting

The Board is preparing a new roster of all diplomates The Secretary would appreciate information concerning anyone who has changed his location since receiving his certificate

B R KIRKLIN, M D
Secretary-Treasurer,
The American Board of Radiology

BOOK REVIEWS

"EXPLORATION RADIOLOGIQUE DES COLONS ET DE L'APPENDICE AU MOYEN DES SOLUTIONS FLOCCULANTES" By GEORGES MAINGOT, Electroradiologiste de l'Hôpital Laënnec, RAYMOND SARASIN, Ancien Interne des Hôpitaux de Geneve et de Zurich, and HENRI DUCLOS, Assistant de Radiologie a l'Hôpital Laënnec. Preface by ANTOINE BÉCLÈRE, Membre de l'Academie de Médecine. A volume of 230 pages, with 203 figures. Published by Masson et Cie, Paris, 1935. Price, 200 fr.

This volume extends the series dealing with the clinical radiology of the digestive tube begun so auspiciously under the authorship and direction of Duval, Roux, and Béclère, to include the large intestine and vermiform appendix. The work merits unstinted praise. Like its predecessors in the series, it might be looked upon as an atlas consisting of excellently prepared reproductions of roentgenographic specimens of the large intestine, terminal ileum, and appendix in normal and abnormal states. It is not, strictly speaking, an atlas, however, for the authors take occasion to describe in considerable detail the anatomic, physiologic, and pathologic basis for the roentgenographic appearance reproduced in the volume.

The book is divided into four parts. The first part deals with the general plan of the roentgenologic investigation of the colon, the technic, and with the anatomic and physiologic factors concerned with the roentgenologic examination of the mucosal surface of the intestine. The second part is given over to a discussion of the interpretation of the various roentgenographic appearances obtained, (a) when the bowel is moderately distended with opaque material, (b) after the opaque material has been evacuated from the intestine, (c) after the bowel has been re-distended with gas. This discussion becomes somewhat involved in spots and, while this reviewer is not in full accord with all the ideas expounded, he feels that a more complete understanding of many an obscure and confounding roentgenographic situation will be the reward of diligent study of this division of the volume. The third part deals in a graphic and instructive manner with the roentgenologic manifestations of abnormal intestinal states, organic and functional. Here again, especially when functional abnormalities are under discussion, one might find in-

stances wherein the interpretation given by the authors might be questioned, but on the whole the material presented is well selected and arranged, and soundly interpreted on the basis of macroscopic pathologic anatomy. The fourth part is devoted to the vermiform appendix, to methods of demonstrating it roentgenologically, and to a consideration of its roentgenologic appearances in normal and diseased states. It seems to this reviewer that the authors have given this subject more intelligent consideration than has heretofore been given it in a single presentation. Nothing precisely new is offered to make the diagnosis of appendicitis an easier roentgenologic or clinical problem, but the authors face the situation squarely, eschew fantastic and far-fetched interpretations, and demand that the roentgenologic diagnosis rest on data reflecting the pathologic anatomy of the disease.

Appended to the volume is a valuable bibliography and a complete index. Outstanding are the reproductions of roentgenograms, all of which must have been magnificent in the original, and the reproductions of them are beyond criticism, displaying an excellence of craftsmanship apparently not attainable in this country or at least not considered to be worthy of attainment. The volume deserves wide perusal and study.

"UROLOGICAL ROENTGENOLOGY A MANUAL FOR STUDENTS AND PRACTITIONERS" By MILEY B. WESSON, M.D., Ex-president of American Urological Association, and HOWARD E. RUGGLES, M.D., Roentgenologist to University of California Hospital, St. Luke's Hospital, and Clinical Professor of Roentgenology, University of California Medical School. A volume of 269 pages, illustrated with 227 engravings. Published by Lea & Febiger, Philadelphia, 1936. Price, \$5.00.

This is written as a manual for the student and the general practitioner and is a useful and timely addition to the literature on this subject. The volume commences with a brief but comprehensive review of the history of urography. The various technics are discussed from the standpoint of experience, fluoroscopic observation is condemned and many practical suggestions are offered with advice as to the number of exposures considered a safe maximum over a given period. With the new

contrast media now available, bilateral retrograde pyelography is almost universally routine. The common causes for error in interpretation are illustrated and explained and a very candid appraisal of the value of intravenous (excretory) urography is offered. The review of the normal and the various factors entering into the variations of the normal is a valuable feature. Renal ptosis is put upon a safe and sane foundation. Congenital anomalies of the kidney and ureter are well illustrated. Hydro-nephrosis is interestingly discussed as to etiology and treatment. Urogenital infections, including pyelitis, pyelonephritis and pyonephrosis, ureteral stricture, obstructive hydro-ureter, inflammatory infundibular stricture, carbuncle and cortical abscess are all succinctly and comprehensively handled. Renal tuberculosis and perinephritic abscess are the subject of useful suggestions in diagnostic methods. Pyelitis cystica, ureteritis cystica, and cystitis cystica are excellently illustrated.

The demonstration of renal calculi is discussed and useful hints are given for the differentiation of artefacts and extrarenal shadows. Fluoroscopy at the operating table and the use of the flexible film for post-operative shock is explained.

The recognition and differential features of renal tumor, solitary cyst, polycystic kidney, adrenal tumors, and Addison's disease constitute the subject of many excellent illustrations and diagrams thoroughly explained in the text.

Chapters on trauma and the neurologic lesions involving the urinary tract, with a discussion of malignant metastatic lesions involving bone, round off an excellent study of the whole subject of urologic roentgenology that is worthy of a place in the library of any one with any interest in this subject.

"ERGEBNISSE DER MEDIZINISCHEN STRAHLENFORSCHUNG (RÖNTGENDIAGNOSTIK, RÖNTGEN-, RADIUM- UND LICHTTHERAPIE)." Herausgegeben von H. HOLFELDER, FRANKFURT A.-M., H. HOLTHUSEN, Hamburg, O. JÜNGLING, Flensburg, H. MARTIUS, Göttingen, H. R. SCHINZ, Zürich. Volume 7, paper, 662 pages with 294 illustrations. Published by Georg Thieme, Leipzig, Germany, 1936. Price, M. 67 50, bound, M. 69 50.

This is the seventh volume of this well-known and favorably received radiologic system. To this number, as to the preceding ones, various

specialists have each contributed a chapter on that radiologic subject with which they are most familiar, either in the field of diagnosis or of therapy. Kommerell discusses right sided aorta, Teschendorf takes up Hand-Schüller-Christian's disease, then Zwerg and Laubmann review Albers-Schönberg's disease (marble bones), Erbsen writes on osteopoikilia, Uehlinger, on myositis ossificans progressiva, Teschendorf, on atelectasis of the lungs, Hernheiser and Strnad close the diagnostic section of this book with a chapter on the perforation of the renal pelvis and ureter as seen in the pyelogram. In the therapeutic part of this book Bickenbach describes the radiotherapy of genital tuberculosis in the female, Dietel, the radium treatment of benign uterine hemorrhage, Zuppinger, the treatment of esophageal carcinoma, Schultz, the radiotherapy of lymphogranulomatosis, Weisswange, the radiotherapy of carcinoma of the breast. As usual, each chapter closes with a bibliography of the important works on the subject under discussion. Reference to the contents of the book is facilitated by an index of both authors and of subject matter. The make-up of this book, its illustrations and all are well up to Thieme's very high standard.

"RÖNTGENATLAS DER ERKRANKUNGEN DES HERZENS UND DER GEFÄSSE." Ein Leit-faden für Ärzte. By DR. W. BREDNOW, Privatdozent für innere Medizin und Röntgenologie, Oberarzt der medizinischen Universitäts-Klinik, Göttingen. A volume of 155 pages, with 87 illustrations. Published by Urban & Schwarzenberg, 1936. Price, 10 50 R M.

Among the various roentgenologic methods of examining the heart and vessels, Brednow favors fluoroscopy and orthodiagraphy. These methods may be supplemented in certain special cases by kymography (which, the author states, is unsuitable for the needs of the general internist) or by plastic modelling of the heart. Roentgenologic examination is of greater value in cases of pulmonary tuberculosis. In cardiac disease the functional study of the heart is of the greatest importance. Yet here a roentgenologic study will give valuable anatomical or pathologic information about the size and shape of the heart. After an illustrated discussion of the normal heart, Brednow discusses in detail the roentgenologic findings in various pathologic cardiac and

vascular conditions This book should be of great value to cardiologists and to internists especially, and to the roentgenologist, who will obtain much help in arriving at a diagnosis which may be of greatest assistance in the prognosis and treatment of a patient with a suspected cardiac or vascular lesion

"THE 1936 YEAR BOOK OF RADIOLOGY" Diagnosis, edited by CHARLES A. WATERS, M.D., Associate in Roentgenology, Johns Hopkins University, Assistant Visiting Roentgenologist, Johns Hopkins Hospital, Associate Editor WHITMER B. FIROR, M.D., Assistant in Roentgenology, Johns Hopkins University, Therapeutics, edited by IRA I. KAPLAN, B.Sc., M.D., Director, Division of Radiation Therapy Department, Bellevue Hospital, New York City, Associate Radiologist, Lenox Hill Hospital, New York City, Clinical Professor of Surgery, New York University Medical College. A volume of 604 pages, 616 illustrations. Published by The Year Book Publishers, Inc., 304 South Dearborn Street, Chicago, Illinois, 1936. Price, \$4.50.

The Year Book of Radiology has already established itself as a necessary addition to the library of everyone who has an interest in roentgenology. It provides an up-to-date manual, profusely illustrated, including almost everything new in a rapidly widening field, for quick reference and comparison in puzzling cases.

The particular value of the book is that the roentgenographic findings are correlated with the clinical and other laboratory and experimental findings in the majority of the presentations. The important features of every paper have been comprehensively excerpted. The volume combines all the values of an interesting film file and a post-graduate course to one anxious to learn or even to the trained roentgenologist as a refresher course.

The section on radiotherapeutics likewise presents this subject both from the side of what can be accomplished and how it may be accomplished in a wide variety of clinically abnormal conditions.

The volume is valuable both to the roentgenologist and to the internist, the specialist and the surgeon, and is worthy of a place in the library of any of these as well as in that of the general practitioner.

"ROENTGENKIMOGRAFIA CONCENTRICA" By ALBERTO C. MORELLI, M.D. From the Institute of Radiology and the Faculty of Medicine of Montevideo, with an Introduction by CARLOS BUTLER. A volume of 70 pages, 32 plates. Montevideo, 1930.

Morelli describes a new type of kymograph differing from the usual devices in that the tracing of the heart in action is concentric. In this way a most accurate picture of the heart and aorta is obtained. Kymograms of the normal heart are presented and analyzed and then pathologic kymograms are discussed in thirty-two plates. The author discusses both the theoretical and practical advantages of his technic over the usual methods of kymography.

"ROENTGENOGRAPHIC TECHNIC" By DARMON ARTELLE RHINEHART, A.M., M.D., F.A.C.R., Professor of Roentgenology and Applied Anatomy, School of Medicine, University of Arkansas, Roentgenologist to St. Vincent's Infirmary, Baptist State Hospital, Missouri Pacific Hospital, and the Arkansas Children's Hospital, Little Rock, Ark. Second edition, 431 pages, 183 illustrations. Published by Lea & Febiger, Philadelphia, 1936. Price, \$5.50 cloth.

This book is an excellent exposition of x-ray technic. The value of this work has already been well established and is one of the standard text-books on roentgenographic technic for x-ray technicians. It should be invaluable to medical students and especially to physicians who do roentgenographic work for themselves.

The author has revised the text thoroughly and has included the advances made in the field of roentgenographic technic. One new chapter has been added, some of the illustrations have been changed, 24 new figures have been provided, and the book itself has been increased in size.

While the general plan of work remains the same, a new method of charting the results of actual diagnostic exposures has been introduced, making it possible to develop a technic in the laboratory itself and with the equipment with which the technic is to be used. His technic may be used in any roentgen laboratory, irrespective of the apparatus that it may contain. The positioning and the special procedures to be applied for each part of the body are clearly presented.

For those not familiar with the First Edition,

the book contains 21 chapters, the contents as follows I Electricity and Electric Currents, II Roentgen-ray Machines, III Roentgen-ray Machines (continued), IV Roentgen Rays or X-rays, V Dark-room Equipment and Technic, VI Introductory Experiments, VII A Basic Roentgenographic Technic, VIII Advanced Experiments, IX Roentgenograms, X. Combinations of Exposed Factors, XI Roentgenographic Technic with the Unit Type Roentgen-ray Machines, XII Miscellaneous Instructions, XIII The Upper Extremity, XIV The Lower Extremity, XV The Vertebral Column, Thorax, and Pelvis, XVI The Head, XVII The Teeth, XVIII The Thoracic Viscera, XIX The Gastrointestinal Tract, XX The Urinary Tract, XXI Miscellaneous Examinations

The author has kept in mind the needs of x-ray technicians, those of medical students in classes of roentgenology, and those of physicians doing roentgenographic work for themselves

This text presents the subject in a thorough, modern, and practical way and should prove of inestimable value to those interested in roentgenographic technic

"KURZ- UND ULTRAKURZWELLEN BIOLOGIE UND THERAPIE" By Priv.-Doz Dr PAUL LIEBESNY, Leiter der Physikalisch-medizinischen Abteilung des Physiologischen Instituts im Allgemeinen Krankenhaus in Wien Vol. 19 of 'Sonderbände zur Strahlentherapie,' 208 pages, 90 illustrations Urban & Schwarzenberg, Berlin, 1935 Price, \$ 50 R.M

Liebessny, who is one of the pioneers in this new form of physical therapy, first discusses the historical and theoretical basis of short wave treatment, and substantiates much of it from his own experimental work. He feels that Hertzian waves have a specific biologic effect in addition to their thermal one, and contrasts the therapeutic effect of these waves with those obtained by diathermy. He evaluates his therapeutic results very conservatively and warns against over-enthusiasm for the method.

For the generation of Hertzian waves the author favors tube rather than spark gap apparatus. The effect of Hertzian waves on various biologic objects is discussed in some detail. Further, the effects of these waves on

various inflammatory and malignant lesions and on pulmonary and nervous diseases are illustrated photographically and the author contrasts treatments of various kinds carried out at different wave lengths. In the final (fifth) chapter there is an explanation of the technical side of the therapeutic application of short and ultra-short wave radiations.

A bibliography of 17 pages includes all important works in this field. The book should be of interest to the physical therapist or internist rather than to the roentgenologists, who can, nevertheless, read the volume with interest and profit.

"EXPERIMENTAL STUDIES ON A TRANSMISSIBLE MYELOMATOSIS (RETICULOSIS) IN MICE" By OTTO KAALUND-JORGENSEN Supplement 24 of "Acta Radiologica," paper, 142 pages, 25 illustrations. Published by Levin & Munksgaard, Copenhagen, 1936 Price, Swed cr 12

This monograph is concerned chiefly with a presentation of the extensive experimental studies of the author on the transmission of myelomatosis (myeloid leukosis) in mice. A good review of the literature on the subject is presented in the first chapter. Subsequent pages deal with (1) the various methods of transmitting the disease to pre-irradiated and non-irradiated animals of the same and different strains, (2) heterotransfer, and (3) histologic and hematologic studies of the organs of animals that had succumbed to the disease. Much of the material is a confirmation of work recently reported by other investigators. The author stresses the differences between the filtrable tumors and leukoses of fowls and the transmissible tumors and leukoses of mammals, and especially the fact that in mice the disease cannot be transmitted by absolutely cell-free agents. Evidence is presented to show that the transmission of the myelomatosis in non-irradiated mice depends to a considerable degree on the genetic constitution of the animals, that the resistance determined by hereditary factors can be destroyed by general irradiation with roentgen rays. The report of successful heterotransfer of the myelomatosis from mice to pre-irradiated rats, re-transmission through two passages in irradiated rats, and then transmission back to non-irradiated mice is of considerable interest since heterotransfer of the disease has never been successfully accomplished before. The lethal roent-

gen dose for the myelomatosis of mice was found to be between 3,100 and 3,700 r

In the chapter on the histologic and hematologic studies of the disease, the author presents evidence to demonstrate that this condition fulfills the criteria of a myeloid, rather than lymphoid leukosis, namely, that it is a progressively fatal disease characterized by immature myeloid elements in the blood stream, hyperplasia of the bone marrow, and leukemic infiltrations in the various organs and tissues of the animal. A number of photomicrographs and one colored plate illustrate this.

The English translation is seemingly too literal in certain sections of the book, resulting in choppy style, poor sentence construction, and occasional obscurity of the exact meaning of the author. Nevertheless, this work should be of interest to pathologists, hematologists, roentgenologists, and investigators, in general, who are interested in the various problems relating to the leukemias.

"OPERATIVE AND INTERPRETIVE RADIODONTIA. A Textbook for Students and Practitioners of Dentistry." By WALTER S. THOMPSON, D D S, Associate Professor of Radiodontia, College of Dentistry, University of Southern California, Lieutenant, U S N R, Special Service Instructor in

Radiodontia, Director of Vocational Training in Operative Radiodontia, Los Angeles Junior College, Director of Operative and of Interpretive Radiodontia, Educational Courses offered by the Southern California State Dental Association, Consulting Radiodontist, Los Angeles County General Hospital, Cedars of Lebanon Hospital, etc. A volume of 355 illustrations, 374 pages. Published by Lea & Febiger, Philadelphia, 1936. Price, \$7.00.

Thompson's "Operative and Interpretive Radiodontia" covers the field of technical radiodontia, in particular, in a most comprehensive manner. The book is divided into eleven chapters arranged in such a way that it would be valuable to the dental student, to the practitioner who is installing a new machine, as well as to the practitioner who has had considerable experience.

It contains almost all the methods of worth that have been published, as well as many new ideas of the author's, many of which will be found valuable in this field.

One chapter on "Interpretation of the Dental Roentgenogram" is made up largely of films contributed by a host of different men in the dental profession.

The book is well illustrated and the cuts are very good examples of various dental situations.

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BONE DISEASES (DIAGNOSIS)

Osteochondritis Dissecans of the Head of the Femur
E Friedl Röntgenpraxis, January, 1936, 8, 16-21

Aseptic necrosis of the head of the femur has been as common as aseptic necrosis in the knee joint, in the author's experience. In the Roentgen Institute of the University of Zürich, 21 cases have been seen in the last few years. In 12 cases it was bilateral, in four, on the right side, in five, on the left side. Eighteen cases were males and only three were females. Most of the cases were patients between 20 and 30 years of age. The osteochondritis is usually painless in its beginning and causes symptoms only when a rather large sequestrum has formed. It may be spontaneous on the basis of a constitutional weakness or secondary to trauma. If traumatic, it takes place during the first year after the injury. The necrotic portion of the bone is either absorbed and leaves a permanent defect, or new bone grows into it and replaces it. Arthritic changes are almost always found at a later date.

H W HEFKE M D

BONE GROWTH

The Clinical Significance of Skeletal Roentgen ray Assessment in Children T Wingate Todd Pennsylvania Med Jour August, 1936, 39, 845-848

The author has carried out measurements of bodily maturation in terms of skeletal maturity. The expression of maturity, in terms of union of epiphyses for example may disclose discrepancies between the chronological age and skeletal age. The construction of a skeletal maturity rating table similar to tables of height and weight depends upon long-term study and thus far a provisional table only has been published. In some children skeletal assessments indicate a relatively wide range of variation a scatter which is evident in children who do not enjoy a high degree of constitutional fitness. They evince a constitutional instability which when present in more pronounced form, becomes a retardation in maturity below that of the healthy majority.

The clinical significance of skeletal roentgen-ray assessment in children may also be expressed in a measurement of mineral reserve and its relationship to the pituitary-parathyroid vitamin D complex as well as in the rate of growth of individual bones.

W A SODEMAN M D

THE BRAIN

Discussion on the Value of Radiology in Neurosurgery E W Twining Hugh Cairns M H Jupe Geoffrey Jefferson D W C Northfield and J P Martin Proc Royal Soc Med July 1936 29, 1155-1173

The authors briefly discuss the problems and radiologic criteria employed in the diagnosis of neoplastic and non-neoplastic tumors of the brain and its covering. There is little space devoted to the treatment of those conditions by irradiation.

G E BURCH M D

FRACTURES

Volkman's Ischemic Contracture Associated with Supracondylar Fracture of Humerus Henry W Meyerding Jour Am Med Assn, April 4 1936 106, 1139-1144

This flexion deformity of the wrist and fingers resulting from contraction and fibrosis of the flexor muscles of the forearm affecting children and occurring as a complication of fractures of the lower end of the humerus results in permanent, partial, or total disability when once it is established despite the most expert surgical and physical treatment.

The extensiveness of the primary injury and the time interval between trauma and consultation are of the utmost importance, irrespective of the treatment. Volkman's ischemic contracture can occur even when no treatment has been given. In a matter of hours the damage to the muscle fibers has been done. Conservative methods of treatment, such as the stretching method advised by Sir Robert Jones give the best results. Surgery is resorted to only when conscientious and prolonged treatment has failed to correct the deformity. Physical therapy is the greatest aid in recovery of a useful extremity.

CHARLES G SUTHERLAND M.B (Tor)

GASTRO-INTESTINAL TRACT (DIAGNOSIS)

A Summary of Regional Ileitis with Report of a Case of Colonic Involvement and Suggestion of a New Term A J Rosenblate, A A Goldsmith, and A A Strauss Jour Am Med Assn, May 23, 1936 106, 1797-1800

Crohn *et al* in 1932, designated a number of granulomatous conditions of the intestine possessing common symptomatic and pathologic features variously described for the past three decades. A year later Harris and his collaborators, because of the cicatrizing inflammatory process and the probable involvement of other portions of the intestinal tract suggested the term "cicatrizing enteritis."

No definite etiologic factor or factors have been isolated. The usual site of the disorder is the terminal ileum, though other portions of the intestine may be involved. The pathologic picture is that of inflammation of the ileac mucosa with subsequent ulceration. The intestinal coats are edematous and thickened. The mesentery is thickened and the glands are hyperplastic. Eventually, owing to the fibrostenotic process narrowing of the lumen results. There is a marked tendency toward perforation and the formation of a localized mass in the right lower quadrant and of a fistula into the adjoining intestine.

Roentgenologic investigation is the most essential means of establishing the diagnosis. Abnormalities as revealed by the ingested meal as well as the opaque enema include (a) Filling defects in the ileum just proximal to the cecum (b) abnormality in contour of the terminal loop of the ileum (c) dilatation of ileac loops (in the stenotic phase) just proximal to the lesion.

Kantor's "string sign," while not pathognomonic is strikingly suggestive and characteristic. This has been observed in sarcoma and in syphilis of the terminal ileum.

The authors report a case and suggest the term 'ileocolitis ulcerosa chronica' in cases in which the pathologic condition extends to the colon.

CHARLES G SUTHERLAND, M B (Tor)

Chronic Paralytic Duodenal Stasis J Ducung and P Fabre Arch d Mal de l'App Digestif, June, 1936, 26, 625-651

The symptom-complex of stasis in the second and third portions of the duodenum with no organic obstruction present at operation is reported in a series of five cases. The gall bladders were also found to be normal though no shadows had been obtained following administration of the dye. Clinically there were present dyspepsia and irregular abdominal distress accompanied by a marked emaciation and an earthy complexion.

Fluoroscopically there was seen marked dilatation of the second and third portions of the duodenum with persistent stasis in this segment. Violent and ineffective peristaltic movements as well as waves of reverse peristalsis with reflux of duodenal contents into the stomach were also noted.

Medical treatment, including the use of antispasmodics, resulted in no improvement. The treatment of choice is surgery, a duodeno-jejunostomy.

JOSEPH DAUKSIS, M D

Intestinal Obstruction Due to a Hole in the Mesentery of the Ascending Colon Passage of Descending Colon and Sigmoid through Dense Ring in Mesentery of Ascending Colon Thomas S Cullen Jour Am Med Assn, March 14 1936 106, 895-898

A review of the literature revealed that abnormal openings in the mesentery are rare. They are usually of congenital origin. Injury has not been demonstrated as an etiologic factor in many instances. The openings are most frequently located in the mesentery to the ileum within 2 to 3 inches of its junction with the cecum. When intestinal obstruction results massive resections are likely to be required. Only two cases are recorded in which obstruction of the large bowel occurred. In the author's case there was a ring like opening in the mesentery of the ascending colon. The ring was about two centimeters in diameter and its walls were very firm. Redundant descending colon and sigmoid passing over to the right through the ring shaped opening could not get back and became obstructed. Extreme tension of the mesentery of the distended bowel by pressure had produced blockage of the vessels of the lower portion of the ileum and caused death of more than five feet of the distal portion of the small bowel. Emergency operation was followed by recovery and nine months later the patient was in excellent condition.

CHARLES G SUTHERLAND M B (Tor)

A Combined Form of Ileitis and Colitis Burrill B Crohn and Bernard D Rosenak Jour Am Med Assn, Jan 4, 1936, 106, 1-7

In nine of 60 cases of ileitis surgically treated and confirmed, six were accompanied by a simultaneous inflammatory and ulcerative colitis. The condition has identifying characteristics, clinical symptoms, and a course of its own. Colp, in 1934, published a report of the first case surgically proved, with full details of the pathology.

The authors regard the process as an involvement of both small and large intestines by a similar non specific inflammatory process. The ileum reacting to the infecting agent as a granuloma, the large intestine as an ulcerative and hyperplastic colitis. The relationship is usually not sequential but synchronous. Occasionally however, it appears as a primary ileitis and spreads to the colon.

The diagnosis rests on careful and accurate roentgenographic studies, using both the ungested barium meal and the barium enema.

CHARLES G SUTHERLAND, M B (Tor)

GENITO-URINARY TRACT (DIAGNOSIS)

The Embryologic and Clinical Aspect of Double Ureter Allan B Hawthorne Jour Am Med Assn Jan 18 1936, 106, 189-193

This anomaly is one of the most common of all urinary malformations and the etiologic factor in many renal lesions. There are two types: *complete* (two pelves on the same side, one superior to the other draining by separate ureters and opening by separate orifices on to the floor of the bladder) and *incomplete* (two pelves and two upper ureters joining to enter the bladder by one common ureter). Both these forms of duplication may be unilateral or bilateral. Minor degrees of bifurcation are commonly referred to as bifid pelves.

The embryologic factors concerned are discussed in detail.

In 52 of a series of 63 double ureters some pathologic lesion was present. The two predominating lesions were obstruction with resultant hydro-ureter and hydronephrosis and infection. Evidence of hydronephrosis was present in 48 and 50 of the 52 showed evidences of infection. In the majority of cases the lesion was one of infected hydronephrosis. Of the 52 cases only 13 were treated by operative measures and these all belonged to the group of incomplete bifurcations.

The treatment as far as the double ureter is concerned is really the treatment of the accompanying surgical lesion. For the ectopic supernumerary ureter, complete or partial ureterectomy with nephrectomy or heminephrectomy as the condition indicates.

CHARLES G SUTHERLAND M B (Tor)

Surgical Treatment of Anomalies of Upper Urinary Tract in Children Meredith F Campbell Jour Am Med Assn , Jan 18 1936, 106, 193-196

An anomalous organ is more prone to disease than a normal one. The incidence of anomalous development is highest in the urinary tract. If congenital narrowing of the urethral meatus is disregarded anomalies occur more often in the upper than in the lower urinary tract. If anomalies exist in the lower urinary tract or in the genital system, the chances are better than one in three that the upper urinary tract is anomalous. The suggestive diagnostic corollary of this observation is at once apparent.

In the main, anomalies of the upper urinary tract are important as (1) the renal reserve is diminished (2) the kidney is misplaced or malformed (3) there is urinary obstruction or (4) there is abnormal discharge of urine (ectopic ureteral orifice). Chief interest focuses on the obstructive uropathy for here it is that one encounters (1) congenital hydronephrosis, which comprises the majority of all hydronephroses in children, and even more important if incidence and morbidity are the criteria, (2) chronic pyuria.

Delayed diagnosis of the commoner anomalies of the upper urinary tract too often renders nephrectomy necessary.

The author has tabulated the anomalies in his series and discusses the surgical treatment of the individual types of lesion.

CHARLES G SUTHERLAND M B (Tor)

Rôle of Anomalies of Kidney and Ureter in Causation of Surgical Conditions Robert Gutierrez Jour Am Med Assn , Jan 18 1936, 106, 183-189

With the advent of cystoscopy and catheterization of the ureters and the discovery of pyelography came the recognition of innumerable malformations and pathologic conditions of the kidney that were never before suspected. It can safely be said that fully 40 per cent of all pathologic conditions of the kidney and ureter are due to congenital anomalies. These predispose to poor function, and to urinary stasis with resultant retention and possible infection. Such a condition is potentially a clinico-pathologic entity and liable to become a surgical condition. The development of pathologic lesions in congenitally abnormal kidneys may be relatively silent in some instances. Careful cystoscopic and urographic study should be made in every case in which the slightest urinary symptoms become manifest in patients suffering from various gastro-intestinal symptoms suggesting a lesion of some abdominal or pelvic organ or a functional disturbance of the gastro-intestinal tract. The author reviews the development of the urogenital system and the anomalies resulting from various aberrancies. Their symptomatology is discussed in detail. Diagnosis involves the study of the patient's history, the clinical symptoms and a thorough physical examination. The urologic examination includes cystoscopy, catheterization of the ureters, renal functional tests, roentgenography, pyelography, retrograde (ascending) or excretory (de-

scending), and sometimes cystoscopy and pyeloscopy. The advantages and limitations of intravenous methods are considered. In three comprehensive tables the various types of anomaly to be sought for are tabulated.

CHARLES G SUTHERLAND, M B (Tor)

Ureteropelvic (Renal) Obstruction in the Young Earle R Hall Canadian Med Assn Jour , August, 1936 35, 140-142

Hall points out that renal obstruction at the ureteropelvic junction occurs in childhood more often than is fully recognized but is usually not discovered until adult life after considerable damage has occurred. Complications, such as stone and infection, prompt recognition at a time when conservative treatment is often impossible.

The importance of early recognition is obvious. A careful history may be helpful in bringing out recurrent periods of pain and physical examination may disclose a palpable kidney. However, pyelograms are most helpful, especially the functional pyelogram obtained by the intravenous route, which not only shows the obstruction but demonstrates the ability of the kidney pelvis to empty as well.

W A SODEMAN, M D

HEART AND VASCULAR SYSTEM

Calcifications in the Cardiac Valve Demonstrable Roentgenologically B Kommerell Fortschr a d Geb d Röntgenstrahlen 1936, 53, 34-44

Ten cases are reported in which calcifications of the cardiac valves were diagnosed roentgenologically during life. One of these cases could be confirmed at autopsy. The value of recognition of such endocardial calcifications by fluoroscopy is emphasized. To permit of radiographic demonstration one requires the shortest possible exposures with sufficiently powerful equipment. Calcifications were observed in the aortic valves, the mitral and the annulus fibrosus of the mitral. The possibilities of their localization and differentiation are discussed.

H A JARRE M D

The Symptomatology of an Aneurysm of the Abdominal Aorta Burkhard Kommerell Röntgenpraxis January 1936 8, 25-28

A case of a dissecting aneurysm of the abdominal aorta is described (non syphilitic). It was found below the left diaphragm and had led to a roentgenologically demonstrable impression of the cardia and its displacement close to the anterior abdominal wall. Clinically there were dysphagia, vomiting and abdominal pain but no abnormal abdominal pulsation. An autopsy confirmed the diagnosis.

H W HEFKE M D

Extrapericardial Fat Bodies Friedrich G Kautz and Max Pinner *Am Jour Roentgenol and Rad Ther*, January, 1936, 35, 40-43

These are shadows most commonly seen between the cardiac apex and the left dome of the diaphragm, occasionally between the inferior right border of the heart and the right dome. They are either continuous between these structures or may be separated from the diaphragm by a narrow zone of lesser density. They are triangular, though showing a slight lateral convexity, and may be the same density as the heart or less dense.

It is important to remember that this density is not abnormal. The literature is reviewed and a case is presented revealing the density of both sides of the heart—proven by autopsy.

S M ATKINS, M D

The Roentgen Diagnosis of Aneurysm of the Aortic Sinus Valsalva H U Albrecht *Fortschr a d Geb d Röntgenstrahlen* March, 1936, 53, 218-222

This paper contains a report of three cases of such aneurysm. One was confirmed by autopsy. In two, the aneurysm involved the sinus of Valsalva exclusively. In the third case, however, there was pronounced aneurysmatic dilatation of aorta and innominate artery besides a fist sized aneurysm of the sinus Valsalva. In this latter case there was also extensive calcification of the walls of the aneurysm and erosion of the sternum posteriorly.

For differential diagnosis one will have to consider mediastinal tumor, cyst and inflammatory pericardial diverticula. Syphilis usually is confirmed serologically.

H A JARRE, M D

Four Years of Kymography of the Cardiovascular System Delherm and Fischgold *Fortschr a d Geb d Röntgenstrahlen*, March, 1936, 53, 223-232

This paper emphasizes the value of kymography as developed by Stumpf for the investigation of the cardiovascular system. From their studies the authors have developed the conceptions of "diastolic tonus" and "post systolic residue," and from the application of these conceptions they draw conclusions as to the explanation of extra-systoles and alternating pulse.

The paper will be of interest to those few American radiologists who employ the method of kymography in any of its forms.

H A JARRE, MD

The Roentgen Diagnosis of Aneurysms of the Internal Carotid Artery Andreas Gaal *Röntgenpraxis* June 1936 8, 366-372

Roentgen examination is only occasionally of help in the diagnosis of aneurysms of the internal carotid artery. The roentgen signs are erosions of the neighboring bones.

Two interesting cases are described. One showed slight enlargement of the sella turcica. A double contour

of its base, slight osteoporosis of the bone forming the left optic canal, and a definite enlargement of all foramina in the base of the left skull especially the hiatus of the carotic canal. The clinical symptoms and the effect of ligation proved the correctness of the diagnosis. The second case showed similar roentgenologic changes, best seen on the films of the base of the skull.

It seems possible to employ the roentgen examination in similar cases as a helpful diagnostic means.

H W HEFKE, M D

Reversible Cardiac Enlargement. John E Walker *Jour Am Med Assn*, May 23, 1936, 106, 1795, 1796

Cardiac enlargement is usually associated with valvular defects or with hypertension. Once established in connection with these diseases, the enlargement is, in general irreversible and constitutes a discouraging feature in the treatment of heart disease.

Roentgenograms showing a striking return to normal size of enlarged hearts in arteriovenous aneurysm, beriberi, and myxedema, demonstrate that these three diseases are readily amenable to specific treatment and also that an enlarged heart is not always a permanent irreversible condition.

CHARLES G SUTHERLAND, M B (Tor)

The Roentgen Diagnosis of Non-calcified Thrombi of the Heart Emil Füssl *Röntgenpraxis* June, 1936, 8, 377-380

An intracardiac thrombus can be seen on roentgen examination only if it is calcified or if it changes the contour of the heart shadow. The author has found only one roentgenologically suspected case proved by autopsy. In his own case the contour of the heart and mediastinum was changed so markedly that a mediastinal tumor was suspected. In both hilum regions there was a round, well-circumscribed tumor the size of a child's fist, pulsation could not be made out. At autopsy this tumor was seen to be a greatly enlarged left auricle filled with thrombotic material. An enlargement of the left auricle without corresponding increase in size of the other parts of the heart should make one think of thrombosis of the left auricle.

H W HEFKE M D

Direct Venography in Obstructive Lesions of the Veins Nelson W Barker and John D Camp *Am Jour Roentgenol and Rad Ther*, April, 1936 35, 485-489

Diodrast in 10 c.c. or 20 c.c. quantities has been injected into the veins of parts showing venous obstruction. For upper extremity study 10 c.c. has been found sufficient, while for the lower extremity 20 c.c. is recommended. The injection is made rapidly at the rate of approximately 1 c.c. per second. There are occasional mild reactions (light headedness or nausea and vomiting), but no severe ones and no thromboses. Films must be made rapidly (preferably on the Bucky) immediately after injection for the veins empty rapidly,

even in pathologic cases, so that good visualization of the veins is obtained in only one film

In normal cases the vein injected is usually visualized well up into the trunk, the density of the venogram diminishing centrally with little retrograde visualization of the tributaries. In obstructive cases there is visualization of many diverging and tortuous collateral channels the main venous trunks being visualized for only a short distance beyond the point of injection

The procedure is safe and simple. The only contraindications are recent (within two weeks) acute thrombophlebitis and idiosyncrasy to iodides

J E HABBE, M D

HEMORRHAGE

Rendu-Osler Weber Disease Hyman J Goldstein *Riforma Med*, Feb 22 1936, 52, 256-257 (Reprinted by permission from *British Med Jour*, May 16 1936 p 79 of *Epitome of Current Medical Literature*)

The author gives this name to the condition otherwise known as heredo-familial angiomatosis with Goldstein's recurrent hemorrhages which was described by Rendu in 1896 Osler in 1901 1907 and 1911 Parkes Weber in 1907 and 1924 and Goldstein in 1921. The three essential features are heredity hemorrhages and telangiectases on the skin and mucous membranes. The patients do not bleed excessively after teeth extraction or accidental wounds. The condition has nothing in common with hemophilia essential thrombocytopenia pernicious anemia splenic anemia or Glanzmann's familial thrombasthenia. In some advanced cases the liver and spleen may be enlarged. There are about 120 affected families on record comprising about 850 individuals.

Treatment consists in cauterization of the bleeding telangiectases or the application of x rays or radium to the telangiectases of the spleen or liver. Calcium is administered by mouth or intravenously with or without thrombotic extracts to check the hemorrhage. Snake venom in small doses has been used and preparations rich in vitamins are recommended.

THE HIP JOINT

Roentgen Technic for the Internal Fixation of Fractures of the Femoral Neck Charles H Peterson *Am Jour Roentgenol and Rad Ther* February, 1936 35, 226-229

By the use of the roentgen films of the normal hip the length of the neck and its anterior angulation is determined. This is done by taking a number of films at varying oblique angles of the neck with the film always at right angles to the ray. The femur is rotated until the entire neck is superimposed on the head thus causing the neck to be flat. With a measuring rod attached to the center of the greater trochanter a film taken of this region can thus allow exact measurement of the length of the neck. With the above accurate knowledge the correct size of nail can be chosen. The

nail is driven through the greater trochanter fractured neck, and into the center of the head in stages, each being checked by stereoscopic film examination.

This method permits operation through only a small skin incision, the patient moving about on crutches on the third or fourth day. The nail is removed when the fracture line has healed. The results appear to be very good as non union has not occurred in any one case up to this writing.

S M ATKINS M D

HODGKIN'S DISEASE

Hodgkin's Disease of Bone Marrow and Liver with out Apparent Involvement of Lymph Nodes Harry Herscher *Am Jour Roentgenol and Rad Ther*, January 1936, 35, 73-77

A case of Hodgkin's disease of bone without apparent involvement of lymph nodes is presented only one other case of this type having been recorded in the literature. The case was characterized by an acute clinical course only three months in duration from the onset of symptoms to the time of death. The roentgenograms of the involved bones suggested a metastatic malignancy, in the skull the appearance resembled multiple myeloma.

The frequency of bone marrow involvement in Hodgkin's disease is much more common than is ordinarily suspected and as some investigators believe may be universal in advanced cases.

S M ATKINS M D

Hodgkin's Disease of the Lung Ernest H Falconer and Maurice E Leonard *Am Jour Med Sci*, June 1936 191, 780-788

A study of 29 cases of Hodgkin's disease revealed pulmonary involvement in nine, an incidence of 31 per cent. One hundred and twenty-five cases collected from the literature representing eight authors (including the present authors 29) showed pulmonary involvement in 47 an incidence of 37.6 per cent.

In describing the pulmonary findings the authors present them from the clinical roentgenologic and pathologic standpoints.

Seven cases are reported in detail.

HENRY K TAYLOR M D

The Gordon Test for Hodgkin's Disease Jacob D Goldstein *Am Jour Med Sci* June 1936 191, 775-780

The author describes the 'Gordon Test'—encephalic syndrome in rabbits following the intracerebral injection of suspensions of lymph glands obtained from patients with Hodgkin's disease.

Goldstein studied the rabbit reactions in 29 cases. Of these nine were histologically proven cases of Hodgkin's. The other 20 were suspected of having Hodgkin's clinically but were proven to be the following: tuberculosis (5) chronic lymphadenitis (6) of

these two were infectious mononucleosis, leukemia (2), hyperplastic node (4), lymphosarcoma (3)

Of the nine proven cases of Hodgkin's disease, the Gordon test was positive in seven and negative in two. The Gordon test was negative in the 20 control cases.

HENRI K TAYLOR, M D

Hodgkin's Disease of Bone M C Morrison
Canadian Med Assn Jour April, 1936, 34, 393-396

The author states that the term 'Hodgkin's group' represents an undifferentiated group of atypical cases which seem to be gradations between lymphadenoma, leukemia and lymphosarcoma. These produce three kinds of reaction, the inflammatory, the hyperplastic, and the tumor type, the latter differing from the others in its infiltrative and destructive behavior toward the surrounding tissues, its systemic spread, and the longer course of the disease. Characteristic roentgen changes are mottling, then focal necrosis, erosion of the cortex, gross thickening and lifting of the periosteum in rib and sternal involvement, and (rarely) osteoplastic changes in the chronic disease. In the vertebrae, destruction and collapse are the rule, but the disc cartilage remains intact. Metastatic carcinomas of the osteolytic types, Ewing's tumor, leukemia, and syphilis must be ruled out clinically to confirm the x-ray diagnosis of Hodgkin's disease.

W H GILLETINE, M D

INFECTIONS (THERAPY)

An Analysis of the So-called Bactericidal Effect of Roentgen Rays in Local Infections and in Inflammatory Processes A O Nathanson
Strahlentherapie 1936, 55, 521

The author studied the mechanism of the beneficial effect of small and moderate doses of roentgen rays in inflammatory diseases. The experiments were conducted on the inguinal glands of rats with paratyphoid bacillus B. Roentgen rays have no direct bactericidal effect, neither *in vitro* nor *in vivo*, if used in the customary therapeutic doses. The effect of the rays in inflammatory diseases cannot be explained therefore, by their bactericidal properties but by a change of the tissue reaction to bacteria following irradiation. The bactericidal power of blood and tissue was not found increased after irradiation.

ERNST A POHLER, M D, Ph D

Roentgen Therapy of Certain Infections Fred M Hodges
Am Jour Roentgenol and Rad Ther February 1936 35, 145-155

This subject in this country is not receiving from many radiologists the attention it deserves. In this article only those conditions in which x radiation has definitely proven to be the best method are considered.

Leishmaniasis—Irradiation is practically a specific when the lesion is local. Small early lesions nearly always disappear within twenty-four hours after the

treatment. Large infected areas usually show an early localization with gradual cure within a few days. In some there is a marked walling off or pointing of the infection with the formation of a small central mass which can be lanced. Best results are obtained with 85 kv, 125 r, no filter. This dose is repeated if necessary.

Furunculosis—Owing to the fact that the infection is often deep the best prescription is 125 kv, 125 r, 4-6 mm aluminum filter, at weekly intervals for several treatments. The existing lesions are cured and new ones aborted.

Carbuncle—Irradiation certainly in the large majority limits the spread, lessens the pain, increases drainage, shortens the duration of the disease somewhat, and definitely lowers the mortality. The prescription is 85 kv, 100 r, no filter, for two or three doses. In very early lesions a large filtered dose may abort the condition. There must be close co-operation with the medical man to treat the general condition if necessary.

Infected Rhinophyma—The prescription is 125 kv, 300 r, 4-6 mm Al filter. Several of these conditions were cured by the author.

Infected Angioma—A large dose is necessary but the condition is radiosensitive and excellent results can be obtained.

Granuloma—In the ordinary type consisting of very cellular and richly vascular granulations with associated infection 700 to 900 r unfiltered at 85 kv has given excellent results. In telangiectatic granuloma one to three doses of low voltage unfiltered have invariably produced good results.

Blastomycosis—In some of the serious fungus infections, especially in cases in which the lesions are limited, 500 to 600 r, 125 kv, 4-6 mm Al filter, 10-in. distance, has given excellent results. Iodine therapy should be given along with the radiation.

Parotitis—Many acute, subacute, and chronic cases have almost uniformly responded well with from three to five doses of 125 kv, 125 r, 4-6 mm Al filter and 10-in. distance.

Mikulicz's Disease—Five cases have responded to 200 kv, 100 to 400 r, 1 mm copper, 1 mm Al filter at 50-cm. distance. In several the dose was repeated after four weeks. Mikulicz's syndrome will also respond temporarily to irradiation. The final outcome is of course dependent upon the particular disease with which it is associated.

Localized Infections, Especially on and about the Face—Irradiation in these conditions reaches probably its greatest usefulness in preventing spread to the vessels of the brain or general septicemia. In the slightest spread of the infection to the surrounding fixed tissues, 100 to 150 r unfiltered low voltage, is applied. As a rule rapid walling off occurs within from 6 to 12 hours. If definite improvement within 24 hours has not occurred consultation with a bacteriologist and immunologist is indicated, and suitable other methods of treatment should be instituted, such as the administration of antistreptococcal or other serum.

The value of irradiation on these and other infections has been definitely shown to be due to the liberation of

some substance present in the leukocytes which are destroyed by the irradiation. Thus, in cases in which leukocytic infiltration is slight the irradiation result is not so good. Radiologists have a definite duty to perform, namely, to acquaint the medical men with the value of irradiation in these conditions.

S M ATKINS, M D

THE KIDNEYS

Traumatism of the Kidney W Calhoun Stirling
British Jour Urol, March, 1936, 8, 1-20

Injuries of the renal parenchyma are more common than those involving the pelvis, and represent the average case with mild hematuria, these may heal spontaneously, many of which, however, will later become functionless. The kidney is the most frequently ruptured abdominal viscus and has the best prognosis.

Conservative treatment with supportive measures and a long rest in bed will cure the majority of mild lacerations of the kidney, with the exception of those involving the pelvis, the latter usually require incision, repair, and drainage. Nephrectomy is reserved for severely injured kidneys with torn renal vessels and fragmentation of the major portion of the kidney.

Intravenous urography offers a simple safe method of determining the degree and site of laceration of the kidney, and may be combined with a retrograde urogram if the renal shadow is absent. Individualization of cases is essential as a guide to proper management of renal injuries.

DAVIS H PARDOLL M D

The Kidney Pelvis Its Normal and Pathological Physiology J Leon Jona Proc Roy Soc Med, April 1936 29, 623-628

The author describes his technic and method of study—retrograde urography including fluoroscopy.

He likens the pelvis and calyces to a series of muscular chambers contracting in regular sequence, and separated or connected by muscular valves or sphincters. Because of the muscle tone in the ureter pelvis, and calyces, there is always some urine in the pelvis and calyces—about 8 c.c. the maintenance filling.

The author describes various types of dysfunction affecting the pelvis and ureter. He also describes another method of investigation whereby a graphic record of the contractions of the kidney pelvis is obtained—pyelometry with the aid of a recording tambour attached to an inlying (No 7 or No 8 Charrière) catheter.

HENRY K TAYLOR M D

Ectopic Pelvic Kidney Gilbert J Thomas and J C Barton Jour Am Med Assn Jan 18 1936 106, 197-199

An ectopic kidney is one which is congenitally displaced and has never occupied a normal position. An ectopic pelvic kidney is one fixed within the bony pelvis or across the spine and derives its blood supply

from the adjoining large vessels, such as the iliac arteries.

Reviewing the embryology of the kidney reveals that ectopic pelvic kidney is a defect of development that occurs before the eighth week. The incidence of congenital ectopic kidney is one in 882 autopsies and one in 547 urologic examinations.

The condition may be symptomless and the diagnosis may require cystoscopy, ureteral catheterization, and bilateral pyelo ureterograms either by the retrograde or the excretion method. It must be considered when pelvic tumors are found in either sex, and in the female when abortions occur or when normal pregnancies are interfered with by some abdominal or pelvic mass.

Treatment consists of nephrectomy if symptoms are produced provided the contralateral kidney is normal.

CHARLES G SUTHERLAND, M B (Tor)

The Cause for Extravasation of the Kidney Pelvis and Its Prevention Paul Eichler Röntgenpraxis December, 1935 7, 803-806

Extravasation of the kidney pelvis is defined as any abnormal finding of contrast material outside of the pelvis, for instance a subcapsular filling injection of a tubulus or a pyelovenous reflux. All these not in common findings are due to the technical procedure and not to a pathologic cause. The author has found evidence of extravasation in about 1 per cent of his pyelograms. In another series of cases it happened in 6.8 per cent of the pyelograms. Symptoms due to it were very slight, if any at all. The author warns against colloidal or oily contrast materials. He believes that these accidents may be avoided by careful technic except in a very few cases in which a spasm of the pelvis and calyces might produce extravasation.

HANS W HEFKE M D

THE LUNGS

Cystic Disease of the Lung Herman Hennell Arch Int Med 1936 57, 1-17

The author presents eight cases and discusses the clinical features, the diagnosis, the therapeutic problems and the mechanism of the symptoms and signs of the condition.

Case I Male, aged 46 years. Several oval and round air cysts were present in both lower lobes. One large cyst was filled with fluid.

Case II Female aged 23 years. Pneumothorax was present near the apex of the lung with numerous air cysts below the pneumothorax. The heart and mediastinum were displaced to the opposite side. This case was classed as congenital.

Case III Male aged 46 years. Diffuse fibrotic process involved both lungs with thickening of the pleura and diaphragmatic adhesions. Postmortem examination revealed extensive cystic disease and there was a firm mass which proved to be a large blood clot.

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Int Med

The author's clinical features and the mechanism of the condition.

Case I Male, aged 46 years. Round air cysts were present. A large cyst was filled with fluid.

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Case III Male aged 46 years. Diffuse emphysema involved both lungs with thickening of pleura and diaphragmatic adhesions. Postmortem examination revealed extensive cystic disease and there was a firm mass which proved to be a large blood clot.

lation, more common are the massive foci of consolidation due to silico-tuberculosis. These may be situated in the upper parts of the lung where they result from reactivated apical foci of tuberculosis but frequently they occur in the mid or lower lung. They consist of a very chronic combination of tuberculosis and silicosis progressing simultaneously in the same area. They give rise to much less pronounced symptoms of intoxication than tuberculosis alone. More acute forms of tuberculosis, aspiration disease, and military tuberculosis occur but they are not very common.

Non silicious dusts are generally responsible for an exaggeration of the linear markings of the lung. As far as known, the slight perilymphatic reactions responsible for them do not interfere with pulmonary function and they do not alter the native susceptibility to tuberculosis.

Asbestosis is not so well understood. The roentgenogram shows a diffuse haziness of the lower lung-fields and later a very fine uniform stippling. Whether chronic pleurisy, increased linear markings and conglomerate shadows are due to the dust, to secondary changes incident to collapse of lobules, or to complicating infection, has not been definitely settled. The appearance of a tuberculous lesion in the asbestosis-infiltrated lung is apparently not modified. There may be some tendency toward chronicity.

HANS A. JARRE, M.D.

SOFT TISSUE ROENTGENOGRAPHY

Soft Tissue Roentgenography. Anatomical, Technical, and Pathological Considerations. John R. Carty. *Am Jour Roentgenol and Rad Ther*. April, 1936, 35, 474-484.

By proper technic the following tissue layers may be identified on an x-ray film: skin, subcutaneous dark zone, subcutaneous reticulated zone (panniculus adiposus), fascia, muscle layer, bone. In some instances, particularly at the flexures of extremities, one may identify blood vessels and nerves. If air is injected into the facial spaces and a film made, the author designates it a fasciagram. Muscle detail is better in children and the aged. In the athletic young adult this tissue layer is more amorphous. Enlarged glands may in certain regions, particularly the supraclavicular spaces, be demonstrated which have escaped clinical detection. The uterus and bladder may often be outlined.

Fatty or mucous tumors may be less dense than soft tissue tumors of other composition. Hemangiomas are the only soft tissue tumors the nature of which can usually be determined; these show worm-like structures of increased density due to the blood channels comprising them.

The technic recommended is 100 ma. for two or three seconds, 36 inch distance, and variable voltage (30-70). Films must be developed by sight.

J. E. HANDE, M.D.

TUBERCULOSIS, PULMONARY

Pulmonary Tuberculosis of the Lower Lobe. David Reisner. *Arch Int Med*, 1935, 56, 258.

Tuberculosis of the lower lobe has been considered very rare due to the fact that one frequently fails to make a distinction between lesions of the lower lobe and basal lesions, and that these designations are often used promiscuously. Lesions confined to the superior portion of the lower lobe present neither clinical nor roentgenologic features indicative of a basal process and are in many instances responsible for the somewhat vague term 'hilus tuberculosis'. Oblique and lateral studies of the chest are urged, to assist in accurate localization of the lesions.

Occasionally the lower lobe appears to be markedly diminished in size. This may occur in the chronic case with cirrhotic contraction or in cases with lobar atelectasis following aspiration of blood.

The majority of patients show only a limited area of involvement, usually in the apical or subapical portion of the lower lobe. Cavitation occurs relatively early in these cases. In the lateral projection one notes that the involvement is usually near the dorsal wall. Another interesting and important finding is a sharp demarcation of the superior margin of the lower lobe which is best demonstrated in the lateral or oblique view. The cavities are frequently large and thin-walled and consequently are often mistaken for non-tuberculous abscesses. An interlobar fissure line extending across the annular shadow is practically a conclusive sign that the cavity is situated posteriorly, within the apex of the lower lobe.

In most cases there is a bronchogenous spread into other portions of the lung and not infrequently spreading to the apex of the upper lobe. The author is convinced that there is little, if any, anatomic or pathologic relationship with the hilar structure in this form of tuberculosis.

Tuberculosis of the lower lobe occurs principally in women and is very uncommon in men. The author explains this on the basis of existing physiologic variations in the respiratory mechanism.

Collapse therapy is the only effective treatment and artificial pneumothorax is the procedure of choice despite the location in the lower lobe.

Cystic disease of the lung has to be differentiated from pulmonary tuberculosis, benign bronchial bleeding, bronchial neoplasm, bronchiectasis, tension pneumothorax, foreign body, obstructive emphysema, and putrid pulmonary abscess. The chief complaints included recurring hemoptysis, episodes of pain in the chest and dyspnea, productive cough and foul expectoration.

The following pneumodynamic mechanisms were analyzed: (1) the development of an air cyst, as determined by aplasia or destruction of the surrounding pulmonary parenchyma, with resultant loss of elastic support, (2) the persistence or spontaneous disappearance of a cyst, as determined by the patency of its bronchial communication, (3) the growth and possible rupture of an air cyst, as determined by a check valve type of

well-formed fat deposits on the parietal pleura. The inner muscle layers along the course of the ribs described by Knutsson, usually do not become apparent in straight sagittal chest views. The marginal shadows mentioned are not to be regarded as a pure optic deception, the tangential projection of parietal and visceral pleura at times is sufficient to produce such shadows.

In the anatomic part of this paper several specimens are reproduced showing the fat pads mentioned. It is pointed out in these papers that "lamellar pleurisy" as reported first by Fleischner, in 1927, does occur and may produce quite similar appearance of the marginal portions of the chest.

H A JARRE, M D

PNEUMOTHORAX

Paradoxical Opacities within a Pneumothorax. F Fleischner. Fortschr a d Geb d Röntgenstrahlen, 1936, 53, 45-53.

So-called paradoxical opacities occurring usually in the peripheral portions of the pneumothorax are shown to result from broad pleural adhesions, commonly seen along the dorsal surface of the lower lobe, more rarely of the upper lobe. The production of this roentgenologic image is illustrated graphically.

Such paradoxical opacities offer nothing strikingly new to anyone who has any appreciable experience with pneumothorax therapy.

H A JARRE, M D

RADIATION SICKNESS

Nembutal in the Treatment of Radiation Sickness. G E Richards and M V Peters. Am Jour Roentgenol and Rad Ther, April, 1936, 35, 522-525.

Forty cases of radiation sickness were treated with nembutal. The presence of liver disease is said to contra-indicate the use of this drug and perhaps 1 or 2 per cent of persons do not tolerate barbiturates; however these are rare exceptions. The dose is 1.5 to 3 grains, given preferably one hour before the treatment. In a few cases which appeared to become resistant to the drug even in 3 gr doses the addition of hydrochloric acid in 5 drop doses before meals accomplished further control of upsets. The drug cannot be considered specific for radiation sickness but it constitutes a great boon to the individual who might otherwise refuse to complete the series as planned.

J E HABBE, M D

RADIUM

Advantages and Disadvantages of the Radium Element Pack. James J Duffy. Am Jour Roentgenol and Rad Ther, April 1936, 35, 508-512.

There is no five year result basis on which to judge radium pack efficiency. The early cases are subsequently treated by interstitial irradiation or surgery or both while the late cases present too many intangibles.

The filter of the pack at Memorial Hospital is of platinum and brass equivalent to 2 mm of lead. The effective wave length corresponds to that of highly filtered x rays produced at 1,500,000 volts. Because of low intensity the duration of treatment must be relatively long both in time per treatment and in number of treatments. It is customary to give exposures of two hours per day. At 6 cm, three days are required to give 24,000 mg hr or six days if treatment included both sides of the neck, at 15 cm thirty days of treatment are required.

Comparing 200 kv radiation filtered through 0.5 mm copper at 50 cm distance, 540 r was found to produce the same skin reaction as 190 minutes exposure to the radium element at 6 centimeters. The r output measured by skin effect was 2.8 r at 6 cm, 1.2 r at 10 cm, and 0.57 r at 15 centimeters. However by the usual small ionization chamber measurement the r output from the radium pack was three to four times as much as estimated by skin effect. If this is due to a difference of skin effect caused by shorter wave length, then the skin may be given three to four times as much radium pack radiation as 200 kv radiation, which factor more than offsets the better depth doses obtained by 200 kv radiation at 50 cm as compared to the radium pack at 6 or 10 centimeters. At the present time the longest practical radium pack skin distance is 15 cm.

From a mechanical point of view the radium pack because of its bulkiness and heaviness is difficult to apply to the neck axilla in stout patients and the perineum. The time factor is also in some measure unfavorable, since a two- or two-and-a-half-hour treatment time is difficult for some patients to tolerate.

Despite these mechanical disadvantages of the radium pack and the lack of statistical results the author is of the opinion that the clinical results in some cases of pharyngeal laryngeal breast and rectal tumors and in Hodgkin's is better with the packs than with 200 kv x rays.

J E HABBE, M D

SILICOSIS

The Diagnosis of Silicosis, with Special Reference to Roentgenological Manifestations. Leroy U Gardner. Ann Int Med August 1936, 10, 166-173.

The author's summary is as follows:

Regardless of the history of exposure to dust, a diagnosis of silicosis should not be made until generalized discrete nodular shadows are visible in the lung-fields. Large localized shadows suggest complicating infection but there is a conglomerate type of simple silicosis that occurs in the absence of active infection. It may result from pulmonary damage by previous infection that has healed. It can be differentiated from active infection only by careful clinical study and by repeated roentgenograms to exclude change in the character and size of the lesion. The silicotic lung may exhibit the usual manifestations of tuberculosis superimposed on a background of generalized nodu-

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NO. 2

CANCER OF THE THYROID IN CHILDREN¹

By HUGH F. HARE, M.D., The Lahey Clinic, Boston, Mass.

A SURVEY of 15,000 thyroid operations performed at the Lahey Clinic shows that 258 cases, or 1.7 per cent, were diagnosed as primary malignancy of the thyroid gland. Six of the cases were in children under fourteen years of age, the youngest in this group being six years, the oldest thirteen. Three of the six have been previously reported by Cattell (1). A review and the subsequent course of these cases is given, in addition to the report of three new cases.

There is considerable discrepancy among experienced pathologists regarding the proper classification of thyroid malignancy. We are accustomed to and use Dr. Shields Warren's classification. While it does not reach Dr. Warren's ideal, it is a satisfactory working classification from the clinical point of view. Our classification is as follows:

- Group I (1) Fetal adenoma with blood vessel invasion
- (2) Papillary adenocystoma with blood vessel invasion
- Group II Adenocarcinoma
- (1) Papillary
- (2) Alveolar
- Group III (1) Diffuse small-cell carcinoma
- (2) Small compact-cell carcinoma
- (3) Giant-cell carcinoma
- (4) Fibrosarcoma

It has been noted previously that from 90 to 95 per cent of malignancies of the thyroid develop in pre-existing adenomas, usually in glands in which a single adenoma is present. If early diagnosis and consequently a high percentage of cures are to be attained, this alone is indication for surgical removal of these lesions. Malignancies developing in pre-existing adenoma are largely of the Group I and Group II types. These groups, representing the slower growing tumors and therefore the easiest to cure, make it imperative to arrive at as early a diagnosis as possible.

Tumors making up Group I, namely, the fetal adenomas and the papillary cyst adenomas with blood vessel invasion, grow slowly. Recurrences tend to be local rather than to distant points. Our series of malignancies of the thyroid shows that 95 per cent of these tumors are cured by combined surgery and radiation. This being the group most favorable for treatment, it is unfortunate that none of them occurred in this series.

Tumors making up our Group II, namely, the papillary adenocarcinomas and the alveolar adenocarcinomas, grow more rapidly than those in Group I. They tend to invade surrounding tissues, and recurrences may be local or distant but most frequently spread to surrounding lymph glands, this being the group of thyroid tumors which metastasize to bones. The alveolar adenocarcinomas are more highly malignant than the papillary adenocar-

¹ Presented before the Radiological Society of North America at the Twenty-second Annual Meeting at Cincinnati, Nov. 30-Dec. 4, 1936.

bronchial communication, with a resultant progressive increase in the intracystic pressure, (4) the mechanism of chronic pneumothorax and its relation to recurring cystic rupture, (5) the mechanism of mediastinal displacement and bronchial distortion as produced by large cysts with a high intracystic pressure and (6) the cause of recurring pain in the chest and dyspnea as related to the rupture of air cysts, with resulting tension pneumothorax

The therapeutic measures employed included artificial pneumothorax, extirpation of the cysts and the injection of iodized poppy-seed oil or similar substances into the cystic cavity

E M SHEBESTA, M D

TUMORS (THERAPY)

The Place of Radiation in the Treatment of Cerebellar Medulloblastomas Report of 20 Cases Elliott C Cutler, Merrill C Sosman, and Walter W Vaughan Am Jour Roentgenol and Rad Ther, April, 1936, 35, 429-453

Cerebellar medulloblastomas occur by far the most commonly in early childhood, the peak being in the age-group of five to ten years. They are an uncommon form of tumor forming as they do less than 1 per cent of all intracranial tumors (8.4 per cent of 862 verified gliomas in Cushing's reported series). Pathologically they are soft vascular, and invasive and they may also be transplanted along the cerebrospinal pathways, being most commonly "seeded" by gravity. The location most often met with is in the midline, directly in the fourth ventricle. They do not metastasize outside the central nervous system. Histologically they are highly cellular and vascular the typical cell being a small round or oval one with scanty cytoplasm. Clinically the case is usually that of a preadolescent child (males being affected three times as often as females), who complains of headaches or suboccipital discomfort, occasional morning vomiting without nausea and awkwardness of gait. The head may enlarge unduly fast, and vision is apt to be impaired. In adults headache and vomiting are apt to be minor symptoms tinnitus and deafness being more common.

The course of the lesion is rapidly fatal, death usually occurring within twelve months after onset except for operative intervention or roentgen therapy.

It is important that roentgenologists be familiar with these tumors since radiation therapy plays such an essential part in the control of the case. It is imperative, however, that there be close co-operation between radiologist and neurosurgeon, since dehydration must be carried out prior to radiation and at times surgical intervention is necessary to control reactions of the patient.

The writers are of the opinion that under proper clinical control and preliminary dehydration therapy x-ray therapy may accomplish as long palliation as surgical removal and be attended with practically no mortality, in contrast to the 24 per cent operative mortality in the hands of the best neurosurgeons. These lesions may well be looked upon as the lymphomas of the central nervous system at least insofar as their radiosensitivity is concerned. It is this rapid response of most of these tumors to limited amounts of radiation which justifies attempting to control the case without surgery and biopsy in the authors' experience the test of ten days of radiation will confirm the clinical diagnosis of this pathological type of tumor by the marked clinical improvement.

The technic used is as follows 185 kvp, 4 ma 0.5 mm copper plus 1.0 mm aluminum filter, target skin distance 40 cm, 10.8 r per minute, effective wave length 0.157 Angström, cerebellar portal 10 cm X 10 cm lateral ventricles (right and left) 15 cm X 15 cm, spine (cervicothoracic and thoraco-lumbar) 12 cm X 30 cm maximum daily dose 300 r, maximum field dose 600, except cerebellum which receives 800 r at 200 r daily. Ordinarily it is only the radiation to the cerebellum which must be given with particular care to avoid blocking the aqueduct by edema. After six weeks the cerebellar treatment only is repeated, two months later the entire series (head and spine) is repeated, three months later the cerebellum only is treated, after three months and again after six months the entire series is repeated.

Two cases which have had only radiation without surgery are alive and well one having been symptom-free for thirty five months.

J E HABBE, M D

Thirty-three per cent, or two of our six cases in children, developed in aberrant thyroid tissue

One of our cases which fortunately showed a completely encapsulated adenocarcinoma occurred in a thyroglossal cyst

DIAGNOSIS

With the present methods of clinical diagnosis, the pre-operative diagnosis of malignancy for early cases is practically hopeless. The history of a gland or a pre-existing adenoma increasing in size is suggestive, though not diagnostic. Constitutional symptoms are strikingly absent in the early cases and even in the advanced cases there are few symptoms other than those caused by pressure. Loss of weight is not infrequent. Differentiation from thyroiditis in which the gland increases in size and is firm and hard is many times impossible. It is true that experienced palpators of the thyroid will have higher percentages of correct diagnoses than the untrained but even the best are correct in less than one-third of the cases other than those that are obviously malignant. This means, from the practical point of view, that one must lean entirely upon the pathologist for diagnosis in the early cases. It means that many innocent adenomas must be removed in order to protect the individuals who have or may later develop cancer. In aberrant tissue we know of no way to make the differential diagnosis a certainty other than by biopsy, which we feel should be done in every case.

CASE REPORTS

Case 1 A male child, six years of age, was admitted Feb 10, 1930, complaining of swelling of four weeks' duration in the midline of the neck, the swelling becoming progressively more marked, yet unaccompanied by constitutional symptoms. The physical examination was negative except for a lump-sized mass in the neck. A clinical diagnosis of thyroglossal cyst was made and operation advised.

On Feb 12, 1930, a radical resection of the cyst was performed and, while there was no suspicion of malignancy pre-operatively nor at operation, the pathologic diagnosis was adenocarcinoma arising in and completely encapsulated in a thyroglossal cyst. Fourteen days after the first operation, a wider excision was made because of the pathologic report.

In October, 1930, the patient returned for a routine check-up, at which time the cyst had recurred, another excision was advised and performed on Oct 17, 1930, at which time no evidence of carcinoma clinically or pathologically was found. X-ray treatment was advised, but refused by the child's parents.

A letter from the boy's father three years post-operatively stated that his son was in perfect health and had had no trouble with his neck since operation.

This is a six-year good result treated entirely by surgical means, and is one of the earliest carcinomas we have had. It is to be noted that the tumor at the time was entirely localized within the cyst wall (Fig 1).

Case 2 An 11-year-old girl entered the Clinic on Jan. 25, 1930, complaining of lumps in the neck of one and one-half year's duration. The lumps had, from time to time, shown some evidence of growth, but previous treatment before entry had decreased the size of the glands before we saw them. There were no constitutional symptoms and, except for the glands, the child was apparently in good health.

Nine months previous to entry, a biopsy had been performed on one of the glands. The pathologic report at this time had been normal lymphoid tissue. Again three months before entry, a second gland was removed. The pathologic report at this time was papillary cyst adenoma arising in aberrant thyroid tissue. X-ray treatment was advised and given at this time. The child received a total of eight treatments in one and a half months. The exact details of the treatment were not recorded. The glands became definitely smaller fol-



Fig 1

Fig 1 Case 1 Photomicrograph of tissue from adenocarcinoma arising in and completely encapsulated in a thyroglossal cyst

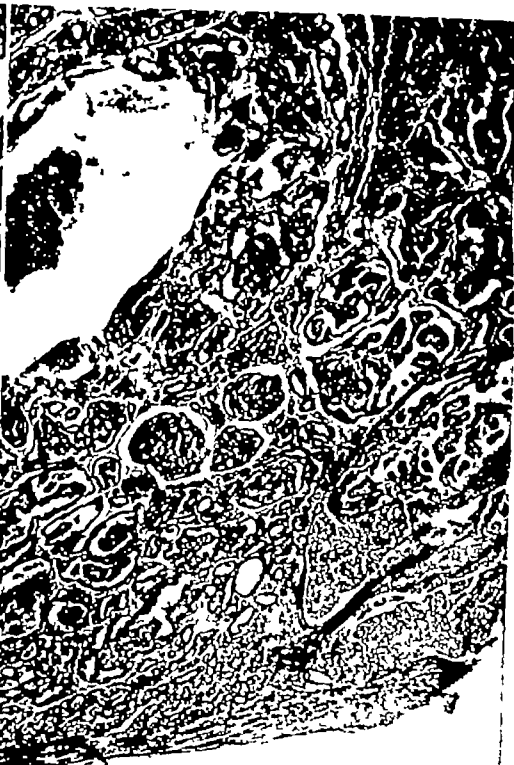


Fig 2 A

Fig 2-A Case 2 Photomicrograph of tissue from papillary adenocarcinoma (Grade II) arising in aberrant thyroid tissue

cinoma and, therefore, have proven themselves more resistant to treatment. Four of our six cases fall into Group II.

Group III malignancies, namely, the diffuse small-cell, the small compact-cell, the giant-cell carcinomas, and the fibrosarcomas are the most rapidly growing of thyroid tumors and represent the group most difficult to diagnose pathologically. The pathologic classifications for this group of tumors are varied and confusing. The history of a rapidly growing tumor and the presence of a non-encapsulated diffuse hard tumor must aid in making the diagnosis even when one is accustomed to the various classifications. These tumors are more radiosensitive than the other thyroid tumors but are not as radiosensitive as the lymphoblastomas which the small compact cell tumors closely resemble microscopically. Two of our cases

in children have been tumors of this type.

Tumors of thyroid origin may occur in aberrant thyroid tissue, that is, in lateral and medial aberrant thyroid masses and in thyroglossal cysts. These tumors are frequently malignant. Cattell and Albright have recently reviewed 30 cases of aberrant thyroid tumors which have been treated in the Lahey Clinic. Of these, 60 per cent, or 18, were malignant. Further, aberrant thyroid tumors, as one would expect, occur most frequently under forty years of age, 63 per cent of our cases being under this age. Clinically, the differential diagnosis between this type of tumor and other tumors occurring in the neck, such as lymphoblastoma, tuberculous cervical adenitis, dermoid cyst, thyroglossal cyst, branchial cleft cyst, chronic cervical adenitis, and metastatic carcinoma is usually impossible.

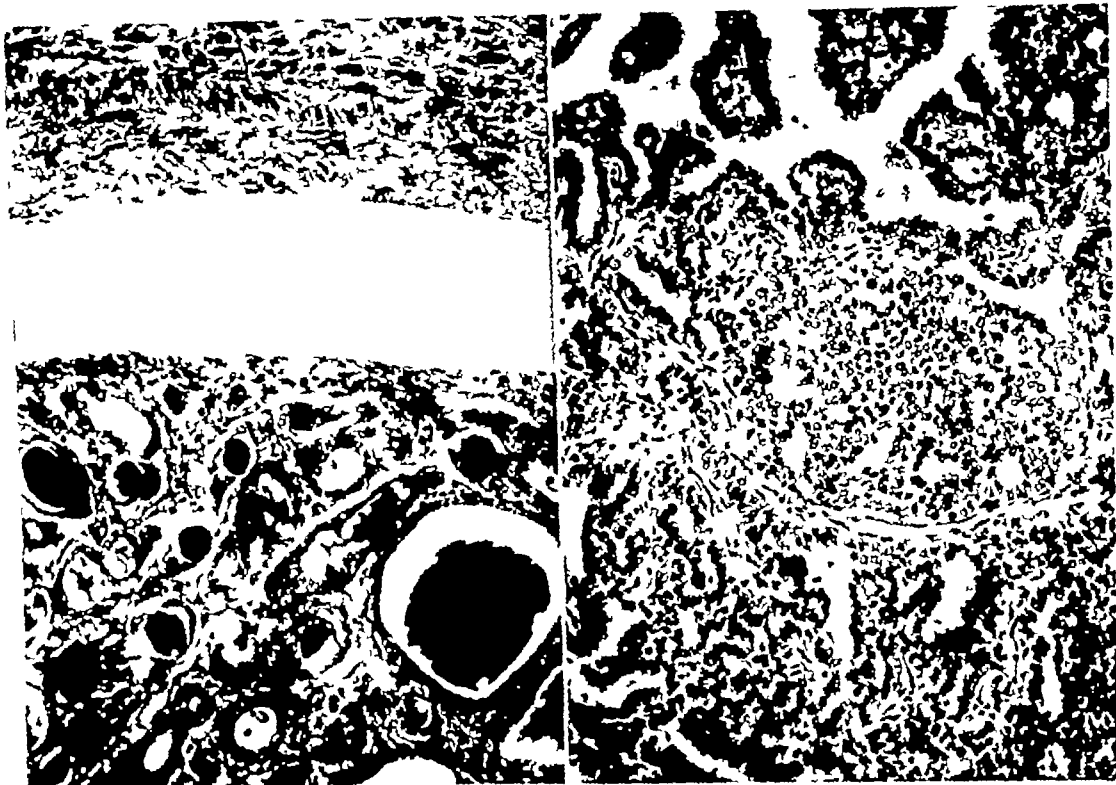


Fig 3-B

Fig 4

Fig 3-B Case 3 Photomicrograph of tissue from adenocarcinoma arising in the isthmus of the thyroid gland

Fig 4 Case 4 Photomicrograph of tissue from papillary adenocarcinoma arising in the thyroid gland

thyroid which involved the isthmus and which was fixed to the trachea

The pathologic report was adenocarcinoma with blood vessel invasion. On Oct 29, 1935, the patient was referred for x-ray therapy. Examination at this time revealed a small gland just above the right clavicle medially which was firm and non-movable. A diagnosis of recurrence was made at this time and agreed to by the members of the tumor clinic.

A series of 33 x-ray treatments was given through four portals, 80 sq cm each, giving 140 r units measured in air, daily, treating through one portal daily, the total dose given to the skin being 4,640 r units. The factors used were as follows: 200 kv p 25 ma 60 cm distance, filtered through 0.5 mm copper and 1 mm aluminum.

The mass which was noted at the start of the x-ray treatment increased in size

during the first ten days, then gradually decreased until it was no longer palpable. There was a fairly marked roentgen dermatitis of the anterior portion of the neck accompanying and following the treatment, but about three weeks after the treatments were finished, the skin returned to normal. There were practically no constitutional symptoms noted in using this type of treatment, except that the child complained of sore throat and of some difficulty in swallowing, but this was not marked enough for the child to lose any weight during the course of treatment.

The child remained clinically well following treatment and on March 7, when she returned for a check-up examination four months after the x-ray treatment had been started, a small gland was noted about 3 cm above the medial end of the left clavicle. It was decided at this time that further x-ray treatment was not in-

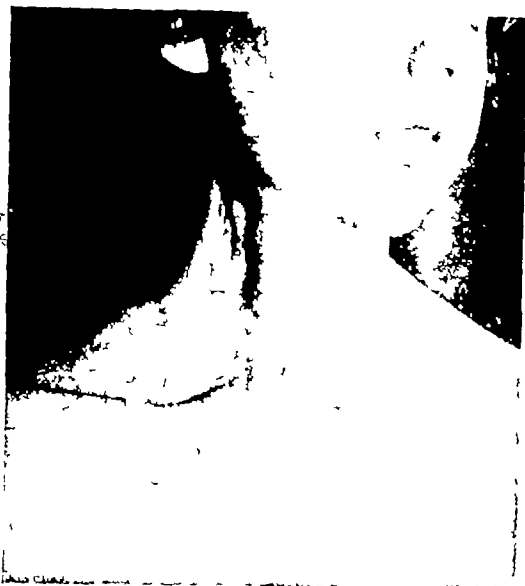


Fig 2-B Case 2

lowing x-ray therapy but did not entirely disappear

On Jan 29, 1930, Dr Frank H Lahey performed a radical resection of the right side of the neck. The pathologic report at this time was papillary adenocarcinoma, Grade II, arising in aberrant thyroid tissue. There was no evidence in the pathologic slide of either roentgen reaction or destruction of the tumor cells. Post-operatively, two more x-ray treatments were given, but again the factors used were not recorded.

Three years later, during a routine check-up, a small gland was palpated near the medial end of the right clavicle. This remained the same size for another three years without other evidence of recurrence developing. In July, 1936, the gland was removed surgically. The pathologic report at this time was papillary adenocystoma, malignant. Further x-ray treatment was advised, but because of beginning telangiectasia of the skin and the "red-headed" complexion of the patient, small doses were necessarily applied. A series of twelve treatments of 200 r each were given through two portals of 80 sq cm each, one on each side of the neck, using the following factors: 200 kv p, 25 ma,



Fig 3-A Case 3

filtered through 0.5 mm copper and 1 mm aluminum, the treatments being given daily for a total dose of 1,200 r units to each portal. There was only slight skin reaction following treatment. The patient is now clinically well nearly six years after the first operation (Fig 2-B). While the pathologic report has varied in this case on four different occasions, it merely serves to point out that different types of malignancy may be present in the same case. (See Fig 2-A.)

Case 3 An eight-year-old girl entered the Clinic on Oct 10, 1935, complaining of a swelling in the neck of one year's duration, the mass having increased in size during the previous three months. The child was in good condition, without symptoms, except that the mother had noticed that she had become nervous along with the increase in size of the mass.

The physical examination was negative except for a dome-shaped, hard, smooth nodule about 2.5×3 cm in size, slightly to the left of the midline of the neck just above the sternal notch.

The basal metabolic rate was plus and minus 0 on Nov 11, 1935. Owing to the firmness of the lesion, a pre-operative diagnosis of questionable malignancy was made. On Oct. 11, 1935, Dr R B Cattell excised a lime-sized adenoma of the



Fig 5

Fig 6-A

Fig 5 Case 5 Photomicrograph of tissue from carcinoma of the small cell type.

Fig 6-A Case 6 Photomicrograph of tissue from small-cell compact type carcinoma of lateral aberrant thyroid

of the clinical appearance of the child, a pre-operative diagnosis of malignancy was made. Consequently, on Oct 27, 1930, Dr R B Cattell performed a tracheotomy, at which time we took a biopsy, as excision was impossible. The pathologic report was carcinoma of the small-cell type, Grade III. The patient was given three series of x-ray treatments between November, 1930, and February, 1931. The factors used were not recorded, but the mass gradually shrank to about one-fourth the size at entry. In the Spring of 1935, the mass began to increase in size again but further treatment was refused. The patient died at home in December, 1931, fourteen months after his first visit to the Clinic and seventeen months after the first symptoms were noted. This is a case representing a rapidly growing tumor of the thyroid gland, wherein good

response was obtained by radiation, but, unfortunately, the necessary amount of treatment to control the lesion even locally was not given, which I feel is definitely a mistake. In many of these cases the disease may be quite advanced without metastatic involvement and every possible attempt should be made to give enough radiation to prevent a recurrence (See Fig 5).

Case 6 A young Jewish girl, nine years of age, entered the Clinic on Nov 26, 1934, because of an enlargement of the neck of two months' duration, associated with easy fatigability, irritability, nervousness, rapid pulse and a feeling of more than usual warmth. She had lost two pounds in weight over a period of five months.

The physical examination revealed a poorly nourished young girl, obviously

licated as this nodule was close to the skin and it was small enough to be treated easily by radon insertion. Accordingly, 1 mc of radon, screened through 0.3 mm gold, was placed in the center of the small gland. The gland gradually decreased in size and two months later was not palpable. The patient has remained well to date without evidence of recurrence, having gained ten pounds in weight and grown nearly three inches in height. This represents a case in which it was necessary to supplement the surgical and x-ray treatment with the use of radon. (See Fig 3-B.)

Case 4 A 13-year-old Jewish girl came to the Clinic in October, 1935, complaining of "goiter" of six months' duration. Her mother had noticed that the thyroid gland had recently increased in size and that it moved up and down noticeably on swallowing. No constitutional symptoms were noted.

The physical examination revealed a well developed and nourished Jewish female, weighing 135 pounds which was her highest weight. The examination was negative except for a hard nodule 4 cm in diameter to the left of the midline of the isthmus. The basal metabolic rates were plus 6 and plus 4 pre-operatively.

On Nov 5, 1935, Dr Richard B Cattell performed a left subtotal hemithyroidectomy with baring of the trachea, using cyclopropane CO₂ absorption anesthesia. The operative note is as follows: Using a low collar incision, the pre-thyroid muscles were divided transversely between clamps on the left side, and a discrete adenoma of the left lobe and isthmus, which had definitely undergone carcinomatous change, was exposed. It was adherent to the pre-thyroid muscles superficially and extended down slightly below the clavicle. The inferior thyroid artery was ligated as a trunk. The superior pole was not ligated since it was desirable to leave a slight amount of grossly normal gland—approximately the upper fourth was left. The rest of the lobe was totally excised, baring the trachea in the process. The gland had definitely invaded the

trachea in a small area. The sternomastoid muscle of this side was not sutured. A section between the proximal and distal cut edges was cut out and the stump ligated, thus leaving a wide exposure for x-ray treatment. A small rubber dam was brought out of the left thyroid bed and the skin closed with clips.

The pathologic report by Dr Shields Warren was "papillary adenocarcinoma of the thyroid gland."

On Nov 14, 1935, or nine days post-operatively, the patient was referred for x-ray therapy. The wound was completely healed, but the patient's general condition was excellent, without evidence of recurrence.

A series of twenty x-ray treatments was given through two portals of 80 sq cm each, one on each side of the neck, using the following factors: 200 kv p, 25 ma, 60 cm distance, filtered through 0.5 mm copper and 1 mm aluminum and giving 210 r each treatment for a total dose of 4,200 r units and a dose to each port of 2,100 r, the treatment being given daily.

Three weeks after treatment, the patient returned for observation at which time there was moderate bronzing of the skin of the neck. The wound had completely healed. There were no constitutional symptoms or evidence of recurrence. To date, Nov 2, 1936, the development of this girl has been normal and there is no evidence of recurrence of her malignancy one year following treatment. (See Fig 4.)

Case 5 A 13-year-old male came to the Clinic on Oct 24, 1930, complaining of swelling of the neck of three and one-half months' duration. The swelling had gradually increased in size to the extent that for two months previous to entry dyspnea had been present, especially on exertion. The mother stated that she had noted easy fatigue and irritability, becoming gradually more marked since the start of the swelling of the gland.

The basal metabolic rate was within normal limits, but because of the rapid increase in size of the tumor and because

The use of x-ray treatment for these tumors is a comparatively recent adventure, especially in children. Opinions as to the efficacy of this treatment vary. Group I tumors, that is, the papillary adenocystomas and the fetal adenomas with blood vessel invasion, and the papillary adenocarcinoma which falls under Group II, are agreed upon by all to be radiosensitive. The alveolar adenocarcinomas, the small-cell carcinomas, the giant-cell carcinomas, and the fibrosarcomas are generally considered radioresistant and have been previously so reported by this Clinic (Clute and Warren, in 1934). During the past three years, using a different plan of treatment, we have found that all of these tumors are definitely radiosensitive and that, contrary to opinions previously expressed, they are more so than the Grade I and the papillary adenocarcinomas. The radiosensitivity having been determined, means that x-ray treatment is indicated in all malignancies of the thyroid and it is now our problem to determine the lethal tumor dose of the cancer cell for each individual type. This we are attempting to do now. It will take many cases and several years to do this, but we know now that a larger dose than 1,500 r must be delivered to the tumor cells during one series of treatments and that the probable lethal tumor dose lies close to 3,000 r units.

PLAN OF TREATMENT

In two of our cases (3 and 6), recurrences were noted within two weeks post-operatively, this in spite of careful radical surgery in both cases. It means that x-ray therapy, to be successful, must be given as soon as possible after the diagnosis is made in order to prevent these highly malignant cells from extending beyond the surgical field. There should be no fear of preventing the surgical scar from healing.

In the earlier cases, the treatment given was insufficient and it was largely an artful, rather than a scientific, attempt to destroy the tumor. At first, the treatments were given through a portal large enough to

cover the entire neck, and for good measure the superior mediastinum was included. The doses given at each sitting were large—approximately 500 r—and the filtration light—usually 3 mm of aluminum, at the most, 0.25 mm of copper and 1 mm of aluminum. The skin reaction following this type of treatment was severe, causing a severe radiodermatitis and epithelitis over a large area and later giving rise to disfiguring telangiectatic scars which are potentially malignant.

The present method of treatment is to give as large a total dose as possible over a period of from 30 to 45 days, giving a small daily dose of 100 r to each portal, using as factors 200 kv p, 25 ma, 60 cm distance, and 80 sq cm portal, filtered through 0.5 mm of copper and 1 mm of aluminum. Use of this method will allow a higher total dose with less radiodermatitis and epithelitis resulting. We have been able to give up to 2,000 r per portal by this method.

In giving this larger dose, one must be sure that the nutritional needs of the patient are taken care of. The patients are instructed at the beginning to eat a high carbohydrate diet, in order to prevent, as often as possible, roentgen sickness. In about two weeks, the throat usually becomes so sore that a semi-solid high carbohydrate diet is resorted to. The patients are instructed to use a warm aspirin gargle before meals. During the height of the reaction, a liquid diet is advised, but in some cases the reaction is severe enough to require a 1 per cent cocaine alkaloid oil spray for several days in order to be able to force fluids. Loss of weight during and for three to four weeks following treatment is to be expected. Some of our patients have required hospitalization because of the reaction, but no fatalities have thus far resulted from treatment. The skin of children, while more sensitive than the skin of adults, tolerates treatment equally as well. Large doses, as we have outlined, may be given without fear of permanent skin injury.

We have found that malignancies of the thyroid are most likely to recur within



Fig 6-B Case 6 Appearance of skin following radiation

ill and excited. The skin was warm and moist. The pulse rate varied from 112 to 120. The neck revealed firm fixed glands in front of and beneath the sternomastoids, running up under the angle of the jaw on the right. The thyroid gland was enlarged, firm, and fixed. The basal metabolic rate was plus 35.

A pre-operative diagnosis of malignancy or thyroiditis was made. On Nov 28, 1934, Dr Frank Lahey excised the glands in the right side of the neck. The pathologic report was as follows: carcinoma simplex, small-cell compact type of lateral aberrant thyroid, with metastases to lymph nodes and with blood vessel invasion.

On Dec 6, 1934, eight days post-operatively, the wound had healed except for a small area in the lower end of the scar. There were several small palpable glands on the right, indicative of recurrence. A series of sixteen x-ray treatments was given using three 10×10 portals, one on each side of the neck and one posteriorly. The following factors were used: 200 kv p, 25 ma, filtration 0.5 mm copper, 1 mm aluminum, distance 50 cm. Three hundred and eight r units measured in air were given at each treatment. Eight treatments were given to the right lateral portal for a dose of 2,464 r units and the other portals received 1,232 r units each. Following the treatment, the patient became dehydrated and acidotic, due to the roentgen sickness and later to radiodermatitis and epithelitis. Hospitalization

was essential for three weeks, during which time several transfusions were necessary and the patient was largely fed intravenously and subcutaneously. Her general condition gradually improved along with healing of the neck. On Feb 2, 1935, a small gland was noted in the right neck about 4 cm above the right clavicle and behind the sternomastoid muscle. On Feb 9, 1935, 3 mc of radon screened through 0.2 mm of gold were placed in the recurrent node. Following this, there was again considerable reaction of the skin. The nodule decreased in size slowly and gradually disappeared. Her voice became low and somewhat husky for a period of nearly one year, then gradually returned to normal. In October, 1935, another series of treatments was given through two portals, giving 1,500 r each and treating through the left lateral and posterior portions of the neck in order to prevent further treatment over skin previously damaged by the heavy radiation.

Following the treatment, the child began to gain weight and now weighs 77 pounds, a gain of 25 pounds since entry. She is now 54 inches high, a gain of four inches, and there is beginning breast development. Her growth and development have been rapid. Now, two years post-operatively, there is no evidence of recurrence, and the skin of the neck is gradually improving, although there are definite telangiectases present along the right side of the neck. (See Fig 6-A)

TREATMENT

The treatment of all tumors of the thyroid is primarily surgical—in the early cases for diagnosis and cure, in the advanced cases for diagnosis and, when necessary, tracheotomy. Treatment should never be instituted when the trachea is constricted by the growth to the extent that there is difficulty in breathing, as swelling may occur following treatment which will make an emergency operation necessary.

cuss his paper was because he expected me to disagree with him. He has presented a very interesting group of cases under the title "Cancer of the Thyroid in Children." He states that at the Lahey Clinic they have observed about 250 cases which they have diagnosed as malignant disease of the thyroid gland, and of these, six occurred in children. We have observed well over 300 cases that we have reason to believe were malignancies of the thyroid gland and not one was in a child. The youngest patient was a girl of 18 years but no other patient under 20 years has had a true malignancy of the thyroid. Obviously, then, there is a discrepancy and this probably is explainable on the basis of differences in opinion about what should be called malignant thyroid disease. Perhaps I may be able to clarify the matter.

I believe that most or all the cases which Dr. Hare has discussed were reported by Dr. R. B. Cattell in 1932. I have studied them previously and also others which have been reported in the literature, including one by Basil Hughes in 1920, one by Elberts and Fitzgerald in 1927, and a recent one by Ferdinand Lee in 1934. All these cases which have been diagnosed as malignant disease of the thyroid in children have points in common which I would like to mention. There is one exception—this is Dr. Hare's case No. 5. A boy 13 years of age was operated upon for a tumor of the thyroid which was said by the pathologist to be a carcinoma of the thyroid of the small-cell type. He was given irradiation and his condition improved, but then a recurrence developed in nine months, after which he died. Undoubtedly this child had a malignant thyroid—there might be some disagreement about whether it was a carcinoma or a lymphosarcoma. From what I have read about this case and from the histologic appearance of the tissue, I would favor the diagnosis of lymphosarcoma, although I am by no means a pathologist.

Now all of the other cases in this and other reports in the literature about which I know have these points in common:

- 1 They all are described as having papillary or papilliferous growths or adenocarcinoma originating in papillary cyst adenomas, aberrant thyroid, or the thyroglossal duct. These terms mean pretty much the same thing, namely, that the growths originated in derivatives of the pharyngeal pouch.

- 2 Distant metastases did not develop in a single instance although many patients had what were looked upon as recurrences.

- 3 Not one patient died prior to the reporting of the case in the literature and some are still well—for a number of years.

These observations bring up several questions necessitating discussion.

- 1 Does the histologic appearance of a tumor always satisfactorily or conclusively determine whether it is malignant or benign?

- 2 If a tissue has histologic appearances similar to those sometimes seen in some thyroid malignancies but the clinical course is benign as far as metastases or the death of some patients is concerned, should the condition be classified as a benign or a malignant disease of the thyroid gland?

- 3 If a tumor is found to have originated in a derivation of the pharyngeal pouch but not in the thyroid gland *per se*, should the case be classified among the tumors of the thyroid gland?

Let us recall that the thyroglossal duct originates as a tubular structure from the embryonic pharyngeal pouch and extends from the foramen cecum in the tongue down the neck in the midline past the hyoid bone to the location of the normal thyroid gland or even occasionally into the mediastinum. It is lined with epithelial tissue and surrounded by connective tissue, including an abundance of lymphatic structures. Normally this tube closes completely, but not infrequently it fails to close somewhere along its course and fistulae, cysts, or tumors may develop. When this developmental error occurs, the lining cells of the tube are confined by the surrounding connective tissue to some extent but they continue to multiply, and this results in folds and infolds that have the histologic appearances we call papilliferous structure.

from 12 to 18 months following treatment. This is an indication for frequent follow-up examinations. We prefer to follow our cases every two months.

DISCUSSION

Cancer of thyroid gland origin in children is rare. Few cases are reported in the literature, but, knowing that it does occur, one must remain cognizant of its occasional presence in children and, therefore, must be on the lookout for it always. The occurrence of cancer in aberrant thyroid tissue and its resemblance to tuberculous adenitis and lymphoblastoma make the clinical differentiation impossible. A careful pathologic examination is imperative following biopsy.

These tumors are definitely radiosensitive and, with proper care, excellent palliative results are obtained in all cases. In many cases, cures will be attained if treatment is given before the tumor has spread over too large an area. While we should attempt palliation in every case, I think, too, that we should try to prevent recurrence in the primary field.

Of our six patients, five are living and well, one is dead of the disease. One patient has gone six years without evidence of recurrence, one developed recurrence after three years which was removed surgically and that patient is now without evidence of recurrence. Three cases are without recurrence two years following treatment.

It is interesting to note that of the five living cases, there have been no deleterious effects upon growth. All of these children have thus far developed normally.

None of these children has developed myxedema thus far, in spite of the heavy doses of radiation and in spite of the radical surgery which has been performed. The cholesterol determinations have remained within normal limits and there have been no clinical symptoms to suggest the disease. This has not been true of all of our adult cases, as about 15 per cent of them have developed a mild degree of

myxedema following surgery and radiation.

SUMMARY

(1) The primary treatment of all tumors of the thyroid gland is surgical.

(2) Cancers of the thyroid gland are radiosensitive and radiation is indicated in all cases. The lethal tumor dose necessary for destruction of these tumor cells is not known, but an attempt is being made to determine this factor.

(3) Growth has continued normally in all of these children following treatment and none of these cases has developed myxedema following treatment.

(4) Two of our six cases occurred in lateral aberrant thyroid tissue and one case occurred in a thyroglossal cyst.

(5) Six cases of cancer of the thyroid in children under thirteen years of age are reported, of whom five are to-day living and well.

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DISCUSSION

DR URSUS V. PORTMANN (Cleveland, Ohio). Perhaps one of the reasons why Dr Hare was kind enough to ask me to dis-

of cases which have been reported here are malignant. He feels, further, that the Group III cases did not arise in aberrant thyroid tissue, that they arose in the thyroid gland.

One of the other cases which recurred shortly after operation was not an aberrant thyroid tumor.

Of the other cases which occurred in thyroid tissue aberrant, both were in lateral aberrant tissue, and we have had no cases occur in the medial type of aberrant tissue.

As to the diagnosis of lymphosarcoma on my case No. 5, I can only say that the

patient did not have the clinical signs that usually accompany a lymphosarcoma or lymphoblastoma, nor have I seen them occur in any of our Group III cases in which the pathologic diagnosis has been small, compact-cell carcinoma. I am quite unwilling to agree to a diagnosis of lymphosarcoma unless the patient will eventually show clinical signs and symptoms compatible with that disease.

So for the time being, I think that we will have to stand by our pathologic classification as it is—the best working classification that we have to date.

in a cyst or a papillary cyst adenoma. Occasionally this confinement of epithelial cells causes them to become very compact masses with little if any recognizable papillary structure—and these are adenomas. Anomalous development of this thyroglossal duct or other derivatives of the pharyngeal pouch may also produce thyroid tissue as aberrant or accessory thyroids at some distance lateral to the midline or in the mediastinum, and this tissue probably may undergo involutional changes like a normally located gland.

The anomalous conditions may become manifest as tumors at any time in life, but especially in childhood, and appear along the course of the thyroglossal tract, lateral to it, outside or inside the thyroid gland or in the mediastinum. Their morphology is essentially papilliferous or adenomatous in character and, therefore, they may have a histologic appearance which may be interpreted as malignancy, but they remain localized and do not destroy vital functions and, in my opinion, are not cancers of the thyroid.

When one of these tumors is excised completely it can never recur. However, the developmental error that caused one of them may also have produced others which may appear later in the same neighborhood or at a distance—even on the opposite side of the neck. These are not recurrences but are new tumors developing coincidentally and if they also are removed they will not recur.

A proof of the non-malignant nature of these tumors is the fact that none of the cases reported in the literature as cancers of the thyroid in childhood, that I know about, have ever developed metastases except the case of the boy previously mentioned. This is not characteristic of malignant disease. Metastases do not develop in spite of the fact that in rare instances the papillary structure apparently has been observed in blood vessels.

Some of these children who were thought to have had malignant tumors have received irradiation and the masses in the neck apparently have been reduced in size

or have disappeared, however, I believe that in almost every case the tumor eventually reappeared and subsequently was removed successfully. It is logical to expect that these epithelial tumors would be as highly radioresistant as are normal thyroid tissue and papillary cyst adenomas in other locations. The temporary improvement that appears to follow irradiation probably is due to reduction in the size of the enlarged lymph nodes, which is nearly always associated with these conditions, and not to any great degree of direct destruction of the cells of the tumor. This is probably the explanation, because, after the treatment, the tumors reappear and are excised successfully, as happened in some of Dr Hare's cases.

I believe that our differences of opinion about what we consider to be malignant diseases of the thyroid have been explained and the original questions answered as follows.

1 The histologic appearance of a tissue is not always satisfactory or conclusive evidence of malignancy, especially when applied to the derivatives of the pharyngeal pouch, including the thyroid gland.

2 Some tumors that originate from pharyngeal pouch derivatives may have some histologic appearances of malignancy but should not be classified as malignant tumors of the thyroid gland, because their clinical course is benign as far as vital functions are concerned.

In my opinion, the cases reported as malignant disease of the thyroid gland were not true malignancies with the exception of one case. I wish to thank Dr Hare for this opportunity to disagree with him.

DR HARE (closing) I did not plan to enter into a discussion as to whether or not these were malignant tumors, since I have left the pathologic study and the decision as to malignancy up to the pathologist, Dr Shields Warren, who has handled more of these tumors than I have.

I have recently gone over our entire series of thyroid cancers with Dr Warren and he feels very definitely that this group

globin molecule Even in dilute solution it lessens its solubility, alters the extinction coefficient, gradually decolorizes the crystals, and may affect the water of crystallization When dried in air, hemoglobin crystals rapidly lose their crystalline structure—which was noted by Halliburton (9) He also found that repeated crystallization of the hemoglobin of the squirrel changes the crystals from hexagonal plates to rhombic prisms or a mixture of these with rhombic tetrahedra

The first notable work on the crystallography of hemoglobins was done by Preyer (10) In a survey of the literature, he comes to the conclusion that hemoglobin crystallizes only in the rhombic and hexagonal system because, of the various hemoglobins studied, these two systems are the only ones definitely proven to exist However, Reichert and Brown (1), after an exhaustive crystallographic study, say that the hemoglobins may crystallize in any system In their study, it was found that the crystals of the species of any genus belong to the same crystallographic system and generally to the same crystallographic group, and they have approximately the same axial ratios, or their ratios are in simple ratio with each other In other words, the hemoglobin crystals of any genus are isomorphous

Hemoglobin is a complex conjugated chromo-protein molecule consisting of a colorless protein radical called "globin," attached to four molecules of a red-brown crystalline non-protein radical called "heme," which gives the color to the molecule Beside the elements usually found in proteins, hemoglobin also contains phosphorous and iron, being one of the few proteins to contain a metal Early workers reported a molecular weight of 15,000–17,000 from calculations based upon sulphur content, iron content, combining power for oxygen and carbon monoxide, etc This value is much too low, as is shown by recent determinations by Wu and Yong (11) from osmotic pressure data, and by Svedberg by means of the ultracentrifugal method Both reported a

molecular weight of 68,000, which is about four times that first reported considering one iron atom per molecule

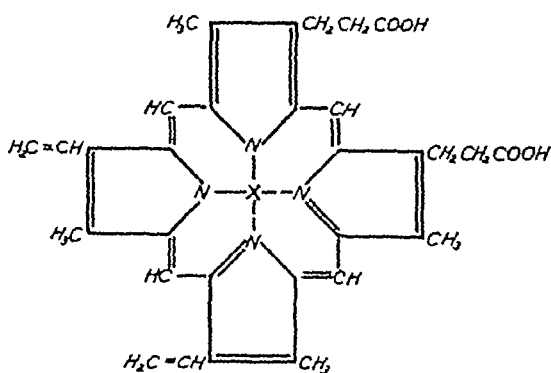


Fig 1 Formula for heme In heme, X = Fe⁺⁺, in hemin X = FeCl⁺⁺

It has long been known that the hemoglobins of different species are different The most marked differences noted have been in crystalline structure, degree of solubility, and in the quantity of water of crystallization The crystal structures are so different that the species can be identified Crystals from ox and hog blood are soluble in their water of crystallization at room temperature, while rat hemoglobin is practically insoluble in cold water Cohn (12, 13) and his co-workers have shown that they differ also in the ratio of amino acids, the amount of iron and sulphur, as well as in their solubility in salt solutions

It was suggested very early that the pigment radical in all hemoglobins is the same and that the differences were due to the globin fraction All later work indicated that this assumption is true The same heme has been reported by Anson and Mirsky (14) to be present in the animal kingdom in a variety of pigments

Hemoglobin can exist in solution, as such, only near the neutral point Dilute acids and alkalis change it into hemochromogen This change, according to Anson and Mirsky (15), is not a separation of the two fractions as it is ordinarily interpreted, because hemochromogen itself is a conjugated protein There are many hemochromogens, each one consisting of

X-RAY DIFFRACTION STUDIES OF GLOBULAR PROTEINS

II HEMOGLOBINS

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HISTORICAL

IN a comprehensive treatise on the crystallography of hemoglobins, which also includes a complete survey of the literature representing the history of hemoglobin crystallization up to that time, Reichert and Brown (1) gave Hunsfeld (2) the credit for the discovery, in 1840, that hemoglobin crystallizes. He found crystals in blood of the earthworm and also refers to crystals from the blood of man and of the pig. Although Hunsfeld's article is the first on record, K. E. Reichert (3), in 1849, gave us the real beginning of our knowledge of hemoglobin when he discovered tetrahedral crystals of hemoglobin in the fetal membranes and the mucous membrane of a guinea-pig which was examined six hours after death. This discovery stimulated workers to study hemoglobin and a number of articles appeared during the next few years. For some time, all of the crystals that were obtained were gotten solely by accident. Funke (4) is said to be the first to have devised a method for preparing blood crystals. His method, which is very satisfactory for the hemoglobins that crystallize readily, consists of the addition of water to blood on a microscopic slide and observation of the edges of the preparation. Some of the corpuscles vanish while others acquire dark, thick outlines, become angular, and develop into small, sharply defined rods. Funke made measurements of the angles of the crystals by the aid of a goniometer and assign the crystals to certain systems even though his data were insufficient. He noted that the forms and solubilities of the crystals of different species are not alike and suggested, therefore, that species may thus be differentiated, the proof of which was fully substantiated by the out-

standing work of Reichert and Brown. In an article coincident with that of Funke, Kunde (5) also stated that the hemoglobin crystals of different species are different and characteristic of the species. Crystals from various kinds of blood which appear to possess a similar form still showed unmistakable differences in the size of the angles.

Since this early work on the crystallization of hemoglobin, many methods have been proposed for the preparation of more or less pure oxy-hemoglobin in relatively large amounts, beginning as early as 1867 by Hoppe-Seyler (6). The method used was essentially as follows: red corpuscles were laked with water, ether, or a mixture of ether and alcohol and from the solution so obtained, oxy-hemoglobin was separated by crystallization in the cold from approximately 25 per cent alcohol. It was not until the present century that methods were devised for the preparation of a purer product. Barcroft and Roberts (7) washed red corpuscles obtained by centrifuging defibrinated blood with Ringer's solution, laked with ether, filtered through a suitable filter, and dialyzed the solution against ice water. Other processes involving the passage of gases through the hemoglobin solution, freezing and thawing, etc., were used, but the most satisfactory methods to be found for the crystallization of hemoglobin are by the addition of alcohol to, or the adjustment of the p_H of a solution prepared by the method of Marshall and Welker (8), to be described later.

The study of hemoglobin is very difficult because, as has been known for some time, it is quite unstable, whether in crystalline form or in solution, especially in concentrated solution, and undergoes rapid alteration, changing into methemoglobin. Alcohol deleteriously affects the hemo-

In 1901, Nencki and Zaleski (17) reduced chlorophyll and hemoglobin to mixtures of volatile bases called "pyroles,"

a copper or iron anticathode, no traces of crystalline diffraction effects could be obtained with freshly prepared hemoglobin

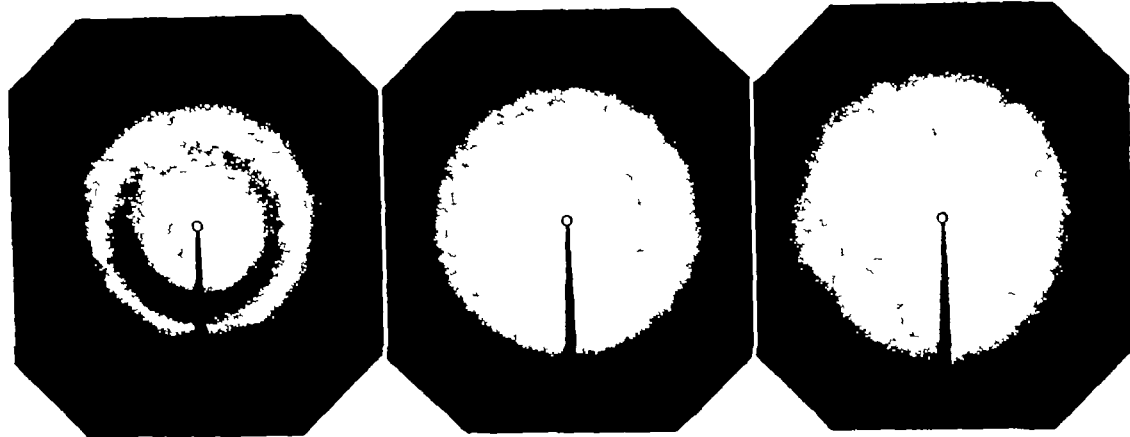


Fig 6

Fig 7

Fig 8

Fig 6 Diffraction pattern of heat denatured hemoglobin

Fig 7 Alcohol precipitated hemoglobin

Fig 8 Hemoglobin, tungstic acid precipitated

thus showing for the first time that pyrole nuclei were involved in the structure of both pigments. Kuster (18), in 1910, proposed the formula given in Figure 1 for hemin which was completely justified twenty years later by Fischer (19) and his co-workers, who established the correct structure of natural hemin and heme for which Fischer received the Nobel prize in 1930. The pigment is one of the porphyrins. Although the substance represented contains 34 carbon atoms, Herzog (20) reported that it can be converted into a 33 carbon compound, which he believes is the prosthetic group of hemoglobin.

The porphyrin ring, according to (21), is both strainless and flat. On drastic reduction of hemin and heme, Dietz (22) reports that the metal drops out and the porphyrin ring breaks on either side of the bridge carbon atoms, forming various substituted pyroles. Oxidation removes the bridge carbon atoms completely.

The x-ray analysis of hemoglobin and its hemin derivative has been very limited. Only three papers have appeared, one of which deals only with the gradual disappearance of the two halos as water was taken up. George (23) stated that, using the powder method with soft x-rays from

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In general, the patterns obtained with hemoglobin are the same as those of the correspondingly treated egg albumin samples, except that the rings are not as sharp. This is probably due to the presence of the pigment fraction of the mole-

an iron-pyrrole molecule (heme) combined with a nitrogen compound. They show that hemochromogen is not simply re-

and the acid groups of heme or a co-ordination binding. The nitrogen group of globin responsible for combination with

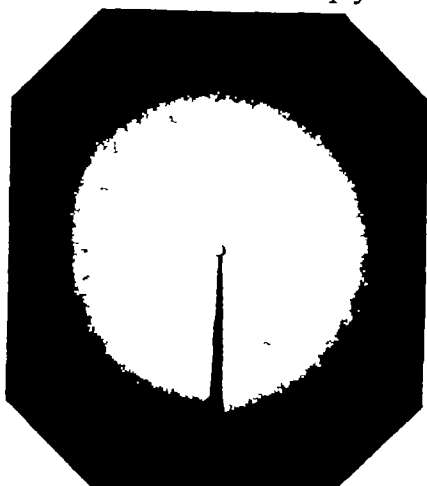


Fig 2

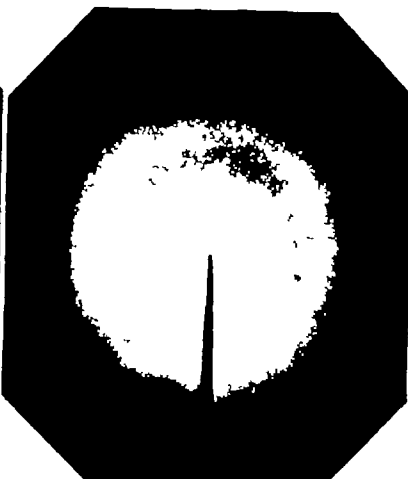


Fig 3

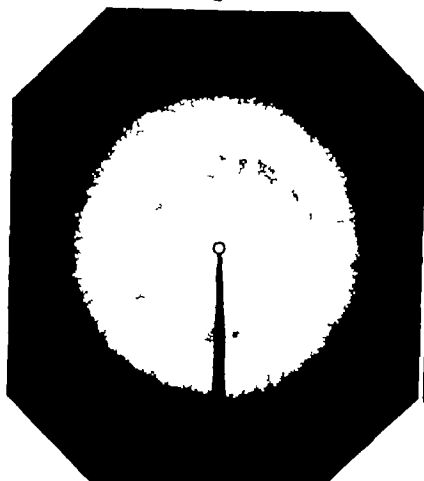


Fig 4

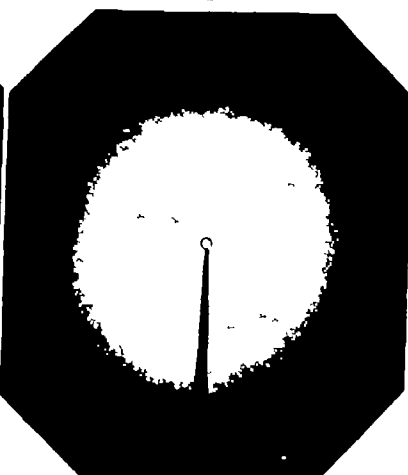


Fig 5

Fig 2 Diffraction pattern of air dried hemoglobin

Fig 3 Salt precipitated hemoglobin

Fig 4 Picric acid precipitated hemoglobin

Fig 5 Trichloroacetic acid precipitated

duced heme, because it can be prepared from reduced heme by adding a protein to it. They prepared hemochromogens from other proteins, amino acids, amines, ammonia, pyridine, nicotine, pyrrole, and other nitrogenous bases and found that they had similar, although not identical, properties. The manner of combination of the two fractions of hemoglobin is not yet known. From the above, it would seem that the combination is probably between a nitrogen group of the globin

heme is not necessarily amino nitrogen, because pyridine, which has no amine nitrogen, readily combines with heme, so the combination may be with tryptophane, histidine, or proline. The combination of globin with heme produces a much more soluble substance. In his work on the oxygen equivalent of hemoglobin, Pauling (16) concludes that the four hemes of the molecule are arranged at the corners of a square, each heme being connected with two others.

In 1901, Nencki and Zaleski (17) reduced chlorophyll and hemoglobin to mixtures of volatile bases called "pyroles,"

a copper or iron anticathode, no traces of crystalline diffraction effects could be obtained with freshly prepared hemoglobin

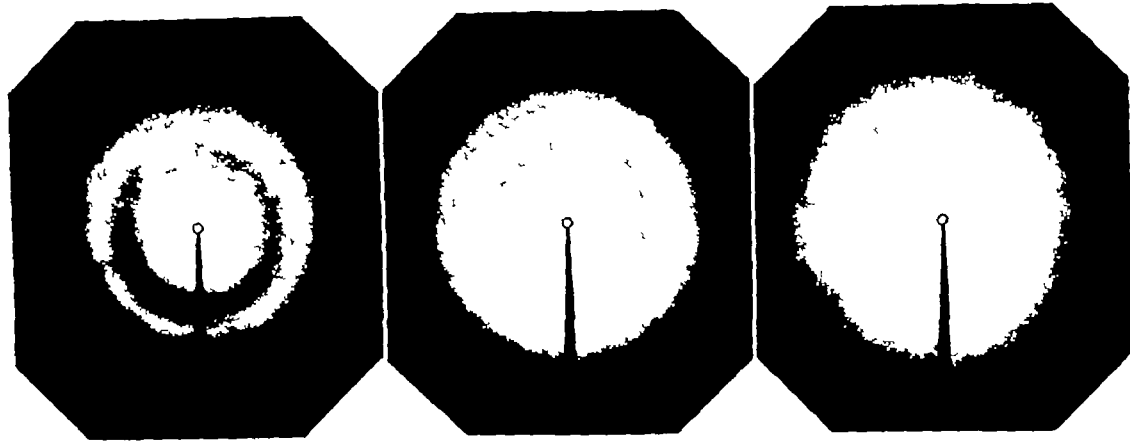


Fig 6

Fig 7

Fig 8

Fig 6 Diffraction pattern of heat denatured hemoglobin

Fig 7 Alcohol precipitated hemoglobin

Fig 8 Hemoglobin tungstic acid precipitated

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In general, the patterns obtained with hemoglobin are the same as those of the correspondingly treated egg albumin samples, except that the rings are not as sharp. This is probably due to the presence of the pigment fraction of the mole-

cule, although it does not affect the diffraction patterns in any other way. The heme is still present in the combined state be-

air-dried hemoglobin but not as sharp as the egg albumin patterns, neither do they show the 3.5 \AA U interference

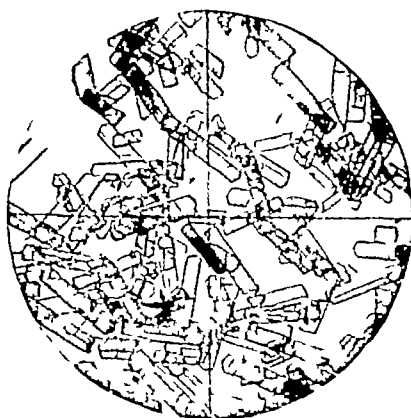


Fig 9



Fig 10



Fig 11

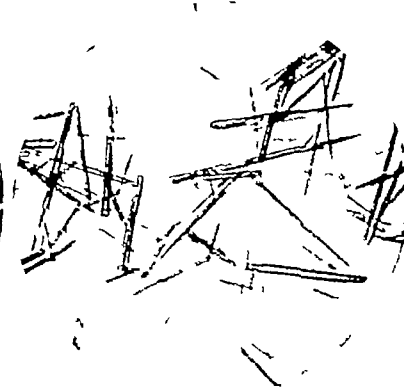


Fig 12

Fig 9 Photomicrograph of rat oxyhemoglobin

Fig 10 Hog carbon monoxide hemoglobin

Fig 11 Horse oxyhemoglobin

Fig 12 Horse carbon monoxide hemoglobin

cause the precipitate is red, which is not the color of free heme, and it cannot be extracted with alcohol.

Figure 2 shows that dried hemoglobin gives the same two rings—the outer one is quite broad and diffuse. Hemoglobin precipitated by salt solutions (Fig 3), and the picric acid product, (Fig 4) gave the same type of diffraction as dry hemoglobin. Again it is noted that the action of trichloroacetic acid on a protein is different from that of picric acid, because relatively sharp rings are obtained. Denaturation of hemoglobin by heat and alcohol gave much sharper patterns than

The tungstic acid precipitate was very highly absorbent but the protein rings appear—if exposed long enough—with rather intense fogging near the central spot.

Crystalline Hemoglobin—The hemoglobin solution was prepared from blood that had been defibrinated by shaking with glass beads and straining through a cloth. The red corpuscles were separated by centrifuging, washed three or four times with 2 per cent sodium acetate solution, and laked with a minimal quantity of distilled water. When the cells are well laked, the solution is very much

darker This solution was treated with a sufficient quantity of aluminum hydroxide cream to remove other proteins Usually more complete removal of other proteins and a more rapid filtration A pure solution of oxy-hemoglobin filters rapidly



Fig 13



Fig 14



Fig 15



Fig 16

Fig 13 Diffraction pattern of rat oxyhemoglobin

Fig 14 Hog carbon monoxide hemoglobin

Fig 15 Horse oxyhemoglobin

Fig 16 Horse carbon monoxide hemoglobin

about four volumes are added It was shown by Marshall and Welker (8), in 1913, that aluminum hydroxide cream removes all of the blood proteins except hemoglobin The aluminum hydroxide cream was prepared by adding 1 per cent ammonium hydroxide slowly, with constant stirring, to a 1 per cent solution of ammonium alum until reaction was just alkaline to litmus The precipitate was allowed to settle and was washed by decantation until the supernatant liquid gave a negative test for ammonia with Nessler's reagent To avoid diluting the hemoglobin solution the cream may be centrifuged and the excess of water poured off Shaking the solution with the cream seems to give a

This is a mild treatment and, therefore, denaturation should be very slight Oxygen was bubbled slowly through this solution in an ice bath for one hour to insure complete oxygenation Absolute alcohol was then added slowly with vigorous stirring and the resulting solution placed in the refrigerator for crystallization, which usually took place over night The amount of alcohol required varies greatly with hemoglobins from different animals, from about 5 per cent for rat hemoglobin to 40 per cent for ox, hog, and sheep hemoglobin The conditions most favorable for crystallization are a concentrated solution and a low temperature Hemoglobin prepared in this way is only slightly soluble in

water but may be recrystallized by dissolving the crystal paste by the addition of N KOH, drop by drop, with vigorous stirring to avoid denaturation and, after the removal of any insoluble material, the addition of any equivalent amount of $0.1\ N$ HCl.

Carbon monoxide hemoglobin is prepared from the above solution by substituting carbon monoxide for oxygen. The solution was carbonylated by saturating with carbon monoxide for one hour, generated by the addition of formic acid to warm concentrated sulphuric acid. The gas was washed twice with a NaOH solution and then with water before it bubbled through the cold hemoglobin solution. Absolute alcohol was added as above and then placed in the refrigerator. Carbon monoxide hemoglobin is much more stable than the corresponding oxy-hemoglobin. The crystals, from which the mother liquor has been removed, maintain their structure for weeks if kept under an atmosphere of carbon monoxide.

The following crystalline products were obtained: rat oxy-hemoglobin, horse oxy-hemoglobin and carbon monoxide hemoglobin, and hog carbon monoxide hemoglobin. The rat and horse hemoglobins were easily crystallized, but the carbon monoxide hemoglobin of hog blood crystallized only after standing in the refrigerator for three weeks. Photomicrographs of the hemoglobin crystals obtained are shown in Figures 9 to 12, and it can readily be seen that there is a distinct difference between hemoglobins of different species.

Rat hemoglobin is probably the easiest to obtain in crystalline form, in fact, a great deal of care must be taken or it will crystallize when the centrifuged cells are laked with water. The crystals belong to the orthorhombic system, but crystallize in thin tabular elongated hexagonal plates. Although some of the crystals are nearly perfect hexagons, most of them have two sides longer than the other four. They show sharp extinction parallel to their long axis when examined in polarized light. The crystals obtained from horse blood are in the form of orthorhombic

prisms, usually many times as long as they are wide. If only a small amount of alcohol is used, so that crystallization takes place slower, the ratio of length to width is increased greatly. Practically no difference is observed in the two hemoglobin preparations from horse blood except that the carbon monoxide crystals are not so long, which fact may be due to the higher percentage of alcohol present during crystallization. Both preparations showed sharp extinction of polarized light parallel to the long axis of the crystals. These crystals were very fragile and were crushed unless extreme care was used in placing the cover glass to protect the sample when observations were being made with the microscope. Even stirring of the crystals suspended in their mother liquor would break them.

It was very difficult to obtain crystals from hog blood because of its high solubility. No crystals were obtained from the oxy-hemoglobin preparation and the carbon monoxide hemoglobin crystallized only after standing in the refrigerator for three weeks. Even then, the crystals were not very well formed. They appeared to be orthorhombic, showing cleavage at right-angles and definitely rectangular etch figures. When examined in polarized light, they showed very sharp parallel extinction.

The diffraction patterns of hemoglobin were obtained by placing the crystals on a porous plate until the mother liquor had drained away and then pressing them into a small hole in a brass strip. The crystals were protected during exposure by thin mica sheets. When the patterns were taken in air, at a distance of 5 cm, it was quite fogged and the rings were too close to the central spot to be accurately measured, so the sample and film were placed in a vacuum camera at a specimen to film distance of 10 centimeters. This greatly improves the quality of the photograph and the accuracy of the measurements.

The diffraction patterns, as well as the photomicrographs, show a distinct difference in hemoglobins from different species (See Figs 13-16). The inter-

planar spacings represented by the various rings, together with their relative intensities, are shown in Table I

The intensities are evaluated thus *v*=very, *w*=weak, *s*=strong, *m*=moderately, *b*=broad, and if there is no designation, the line is of average intensity. All intensities are evaluated relative to the rings on that pattern and are not relative to all the patterns shown. Many of the rings, although easily seen and measured on the film, do not show in the prints but their positions are indicated by ink spots in a straight line across the pattern. The larger spots are produced by the mica windows used to prevent loss of moisture from the sample. Since mica does not give rings, there is no confusion involved by the two patterns being on the same film, as might have been the case if glass had been used.

TABLE I — INTERPLANAR SPACINGS OF HEMOGLOBINS

Rat Oxy Hb	Horse Oxy Hb	Horse CO Hb	Hog CO Hb
46.4 <i>vs</i>	48.2 <i>vs</i>	48.2 <i>vs</i>	48.2 <i>vs</i>
25.6 <i>b</i>	30.8 <i>s</i>	30.3 <i>s</i>	28.5
21.4 <i>w</i>	24.5 <i>w</i>	24.5 <i>w</i>	17.5
17.2	18.9 <i>b</i>	18.4 <i>b</i>	15.1
15.1	13.3 <i>vw</i>	16.4 <i>vw</i>	9.9 <i>vb</i>
12.7 <i>ms</i>	12.3 <i>vw</i>	13.2 <i>vw</i>	
11.6 <i>vw</i>	11.0	12.1 <i>w</i>	
10.2 <i>ms</i> ^{†b}	9.9	10.9	
9.2 <i>w</i>	9.0 <i>w</i>	9.9 <i>ms</i>	
8.1 <i>w</i>		9.0	
7.5 <i>vw</i>		7.9 <i>vw</i>	
5.81 <i>vw</i>		7.4 <i>vw</i>	
5.2 <i>vw</i>			
4.8 <i>vw</i>			

An examination of Table I shows decided differences between the various patterns, except the carbon monoxide and oxy-hemoglobins of horse blood. The carbon monoxide pattern is a little more intense and, therefore, a few more of the very weak lines can be seen. However, all of the patterns show a long spacing of about 48.2 Å U, which is probably the long dimension of the unit cell of crystalline hemoglobin. The slight difference between the long spacing of rat oxy-hemoglobin and the others is easily within experimental error, and, therefore, does not mean that this difference is charac-

teristic. Although it is reported that crystalline hemoglobin is unstable, crystals examined under the microscope after a thirty-hour exposure to x-rays at room temperature still appeared definitely crystalline and also showed sharp extinction. The carbon monoxide hemoglobin of horse blood was allowed to stand at room temperature for two weeks and it still gave a pattern identical with the one taken when first prepared. It seems that the crystals are fairly stable at room temperature if the excess mother liquor is removed. Although x-rays change hemoglobin in solution to methemoglobin, there was no noticeable change in the crystals treated as above.

Rat hemoglobin crystals prepared by the addition of alcohol and by adjusting the *pH* gave identical x-ray patterns. No beta lines could be detected in the patterns, even though a nickel filter was not used.

DERIVATIVES OF THE PIGMENT FRACTION

(a) *Hemin* — Hemoglobin consists of a simple protein called globin combined with the iron pyrrole complex known as heme. The addition of acids under suitable conditions causes a separation of globin and heme, which, during the process of isolation, changes over to its familiar oxidation product, hemin. Hemin differs from heme in that the iron atom has been oxidized to a valence of three and now holds a chlorine atom.

A formic acid hemin was prepared according to the method used by Bruckner (24). Either blood or a hemoglobin solution after the addition of 1 g. of sodium sulphate per liter, was coagulated by heat. The liquid was pressed out of the coagulum and after washing several times with alcohol it was extracted with a 3–4 per cent solution of formic acid in alcohol. The extract was filtered and left at room temperature to crystallize. Although crystals soon began to form, crystallization was not complete for several days. At first, the extract was colored deep red, but upon

standing, it finally became a light tan color and quite transparent

While this procedure worked quite well,

and ethyl alcohols, chloroform, ether, acetone, etc., but is soluble in alkali dissolved in water or alcohol, pyridine, and a mix-



Fig 17



Fig 18

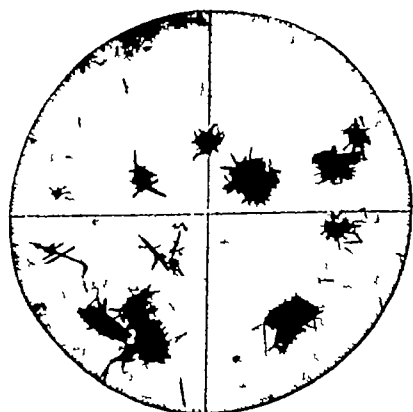


Fig 19



Fig 20

Fig 17 Photomicrograph of formic acid extracted hemin

Fig 18 Chlorohemin

Fig 19 Potassium chlorohemin

Fig 20 Potassium oxyhemin

it was found that better results could be obtained by coagulating the protein with alcohol and allowing it to stand overnight before filtering. The filtrate from this coagulum is clear and colorless and the crystals are mixed with much less of the amorphous looking material which is always present when coagulated by heat.

The crystals form on the sides and bottom of the beaker and adhere tightly to the glass so that it is difficult to obtain good specimens for photomicrographs. The yield of this hemin is about 1.3 gm per liter of blood. It is insoluble in methyl

ture of chloroform and pyridine. Hemin may be recrystallized from the latter mixture by dissolving 1 g in 5 ml, filtering, and pouring slowly into 100 ml of a 10 per cent formic acid solution in alcohol.

According to Bruckner, the substance has an empirical composition corresponding to the following formula $C_{33}H_{33}O_8H_4 \cdot 2(C_2H_5OH)$ and represents a formic acid hemin. The substance yields chlorohemin when heated with acetic acid and sodium chloride. The crystals are very dark in color and transmit very little light, but when examined using polarized light they

show definite oblique extinction. A photomicrograph of the crystals obtained is shown in Figure 17 and the x-ray diffraction pattern is shown in Figure 21. The spacing in Å U of the hemins prepared with formic and acetic acids together with their relative intensities are given in Table II, with those of chlorohemin and potassium oxyhemin.

TABLE II

Formic Acid Hemin	Acetic Acid Hemin	Chlorohemin	Potassium Oxyhemin
12.7 vs	11.40 vs	12.50	32.1 ms
10.2 vs	9.73 w	9.86	14.9 vw
8.4 vw	7.98	8.78 s	10.2 s
6.83 vw	6.94	7.60	6.95 s
5.48 vw	5.58 vb	6.54 w ⁺ b	6.15 vw
5.11	4.94 w	5.34 s	5.73
4.27	4.48 w	4.71 w ⁺ b	5.00 vw
3.84 w	4.06 ms	4.11 b	3.92 vw
3.58 vw	3.63 ms	3.59 vs	3.51 ms
3.34 s	3.24 w ⁺ b	3.39 vw ⁺ b	
3.00 b	2.95 w ⁺ b	3.15 vw ⁺ b	
		2.99 vw ⁺ b	
		2.78 vw ⁺ b	
		2.57 vw ⁺ b	

Diffraction patterns and photomicrographs were prepared of hemins from blood of the following animals: rat, horse, hog, and cow. They all give identical diffraction patterns but the photomicrograph varied a little, as is to be expected.

Either methyl alcohol or ethyl alcohol could be used without affecting the diffraction pattern either in line position or relative intensity. An attempt was made to substitute acetic acid for formic acid but without success, even when the acetic acid concentration was considerably increased. In one case, glacial acetic acid was added to hemoglobin which had been coagulated with alcohol, mixed quickly, and then extracted with methyl alcohol. The filtered extract was much darker than that obtained with 4–20 per cent acetic acid and upon standing, a thin crystalline deposit was formed, which gave the diffraction pattern, Figure 22. It is readily noted that the pattern is quite different from that obtained by formic acid extraction. The nature of the splitting off and extraction of the heme with a cold acid alcohol solution and subsequent crystallization from the same solution without change of

temperature or evaporation has not been explained. Neither have the differences in crystal structure and combination of the formic and acetic acid hemins.

(b) *Chlorohemin*.—In 1900, Nencki and Zaleski (25) prepared a compound which they called “acethemin,” by adding fresh defibrinated blood to hot glacial acetic acid containing sodium chloride. Recently Drabkin and Austin (26) have improved this method by using washed blood cells, thereby avoiding the diluting effect of the serum as well as interferences by serum proteins and lipoids. Neither is filtration required as in the earlier process and, therefore, a better yield is obtained.

Blood cells from defibrinated blood were washed four times with a 2 per cent solution of sodium acetate. The cells were added slowly, drop by drop, with vigorous mechanical stirring, to a hot solution (85–90° C) of glacial acetic acid which had been saturated with sodium chloride at room temperature. The solution became very dark. It was maintained at 85–90° C and the stirring continued for 30 minutes, then allowed to gradually cool to room temperature. Crystallization had already set in but was not complete for two days. The highly colored supernatant liquid was poured off, the crystals allowed to stand under water over night, then washed twice with 65 per cent alcohol for two days, and finally dried in a vacuum desiccator. Less than 1 g of chlorohemin is obtained from 100 ml of cells.

The crystals are purplish-black by reflected light, but, when observed under the microscope, they are from yellow to brown in color, depending upon the size of the crystal. They deposit in the form of elongated monoclinic prisms, as shown in Figure 18. The crystals seem to be quite flat and always appear in the same position on a microscopic slide, indicating that the “b” axis is much shorter than the “a” axis and that it is vertical.

Under polarized light, they show oblique extinction, which is almost parallel to the short edge of the crystal. The diffraction pattern of chlorohemin (Fig. 23),

standing, it finally became a light tan color and quite transparent

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Fig 17



Fig 18

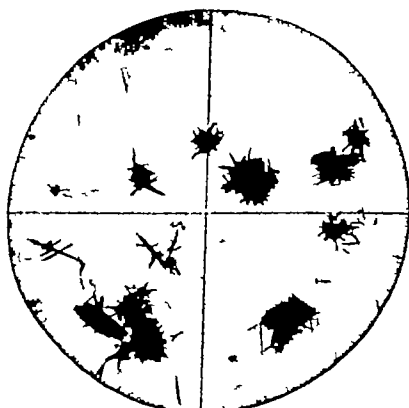


Fig 19



Fig 20

Fig 17 Photomicrograph of formic acid extracted hemin

Fig 18 Chlorohemin

Fig 19 Potassium chlorohemin

Fig 20 Potassium oxyhemin

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The crystals form on the sides and bottom of the beaker and adhere tightly to the glass so that it is difficult to obtain good specimens for photomicrographs. The yield of this hemin is about 13 gm per liter of blood. It is insoluble in methyl

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According to Bruckner, the substance has an empirical composition corresponding to the following formula $C_{35}H_{33}O_6H_4 \cdot 2(C_2H_5OH)$ and represents a formic acid hemin. The substance yields chlorohemin when heated with acetic acid and sodium chloride. The crystals are very dark in color and transmit very little light, but when examined using polarized light they

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TABLE II

Formic Acid Hemin	Acetic Acid Hemin	Chloro hemin	Potassium Oxyhemin
127 vs	1140 vs	1250	321 ms
102 vs	973 w	986	149 vw
84 vw	798	878 s	102 s
683 vw	694	760	695 s
548 vw	558 vb	654 w ⁺ b	615 vw
511	494 w	534 s	573
427	448 w	471 w ⁺ b	500 vw
384 w	406 ms	411 b	392 vw
358 vw	363 ms	359 vs	351 ms
334 s	324 w ⁺ b	339 vw ⁺ b	
300 b	295 w ⁺ b	315 vw ⁺ b	
		299 vw ⁺ b	
		278 vw ⁺ b	
		257 vw ⁺ b	

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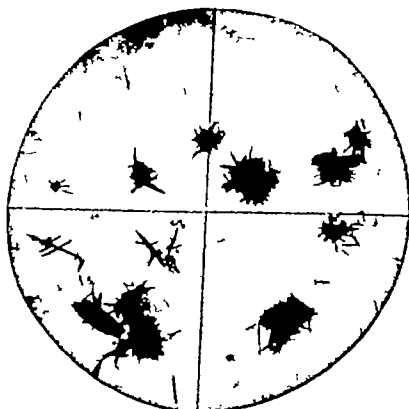


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According to Bruckner, the substance has an empirical composition corresponding to the following formula $C_{35}H_{33}O_6H_4 \cdot 2(C_2H_5OH)$ and represents a formic acid hemin. The substance yields chlorohemin when heated with acetic acid and sodium chloride. The crystals are very dark in color and transmit very little light, but when examined using polarized light they

the name of "potassium oxyhemín" used by Hamsik (27), will be used in this discussion. In his work on the preparation and coupling of the globins, he prepared this substance in crystalline form and was able to couple it with globin to produce a substance whose absorption spectrum was the same as that of alkaline methemoglobin, thus showing its close relationship to hemín.

Blood cells from defibrinated blood were washed four times with 2 per cent acetate solution, hemolyzed with two volumes of water, and centrifuged. To this were added 15 volumes of methyl alcohol and then allowed to stand a few hours before filtering. The residue was extracted with 2 per cent KOH in methyl alcohol, which gave a very dark-colored filtrate. Solid KOH was added to the filtrate until the final concentration was about 10 per cent and then set aside in a stoppered flask to crystallize. In only one case, that from hog blood, were large crystals, as shown in Figure 20, obtained. The mother liquor was filtered off and the crystals were washed with a mixture of methyl alcohol and ether (1-3) and finally with ether. The products from cow and horse blood appeared to be a mixture of crystals and a dark amorphous substance, but Figure 24 indicates that it does not affect the sharpness of the diffraction pattern.

The crystals tend to form a felted mass of needles and are usually very small but they show sharp extinction. They are frequently twinned in the form of a cross at an angle of 60 degrees. They are quite soluble in water and can be changed into chlorohemín by adding this solution to hot glacial acetic acid containing sodium chloride, indicating that it is the potassium salt of chlorohemín. In Table II, the relative intensities of the rings and the interplanar spacings represented by them are given.

Since, as it has already been noted, hemoglobin is split in cold solutions of formic acid and potassium hydroxide in alcohol, it seems quite probable that the

combination of heme and globin is due to co-ordination valences. Due to the nature of the molecules, there are two other possibilities, salt and amide formation. The former is not likely and an amide linkage is not as easily split as is hemoglobin.

SUMMARY

1 Denatured hemoglobin gives diffraction patterns that are very similar to those of egg albumin correspondingly denatured but the rings are not quite as sharp, which is probably due to the presence of the pigment fraction of hemoglobin.

2 Photomicrographs and diffraction patterns of rat and horse oxy-hemoglobin and horse and pig carbon monoxide hemoglobin are shown. Although the two horse hemoglobins give identical x-ray diffraction patterns, there is a very marked difference between them and the other two, as is also noted in the photomicrographs.

3 The presence of moisture was necessary to maintain the crystalline structure of these proteins.

4 Hemín prepared by extracting hemoglobin with formic acid in alcohol gives a crystalline product, which is the same for rat, cow, pig, and horse hemoglobins, as shown by identical x-ray diffraction patterns. An improvement in the method is given. This hemín was changed into chlorohemín with acetic acid and NaCl.

5 The chlorohemíns of the above-mentioned hemoglobins give identical diffraction patterns. Chlorohemín was changed into potassium oxyhemín by dissolving in 2 per cent KOH in methyl alcohol and adding solid KOH. It was recrystallized by dissolving in a small amount of a pyridine-chloroform mixture and adding this to glacial acetic acid containing NaCl.

6 An extraction of alcohol precipitated hemoglobin with 2 per cent KOH in methyl alcohol gave a crystalline product called potassium oxyhemín. The oxyhemíns of cow, horse, and pig blood were shown to be identical. It was changed into chlorohemín by adding its water solution to glacial acetic acid containing NaCl.

consists of sharp rings, and a comparison with Figures 21 and 22 shows that this substance is distinctly different from the

cent A photomicrograph of these crystals is shown in Figure 19 The diffraction pattern is similar to that of potassium

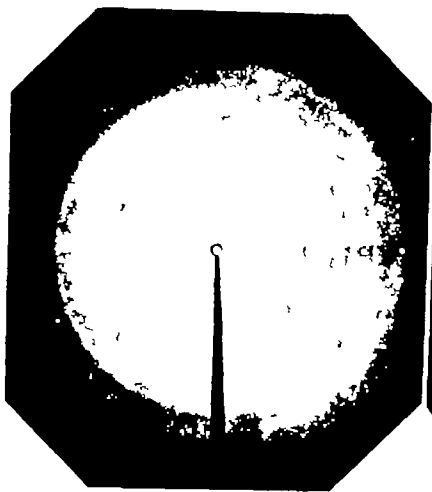


Fig 21

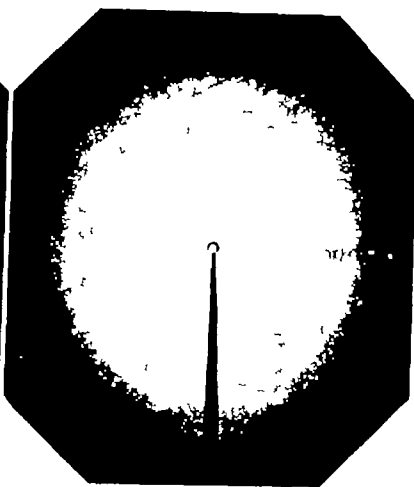


Fig 22

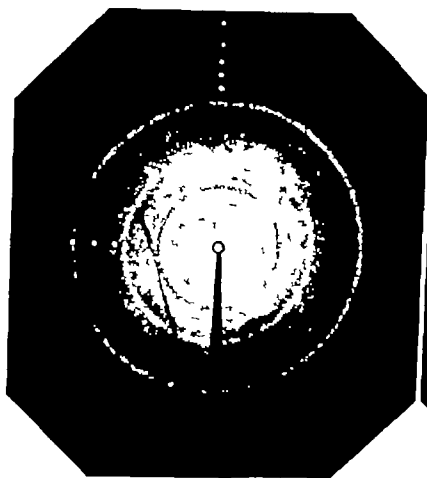


Fig 23

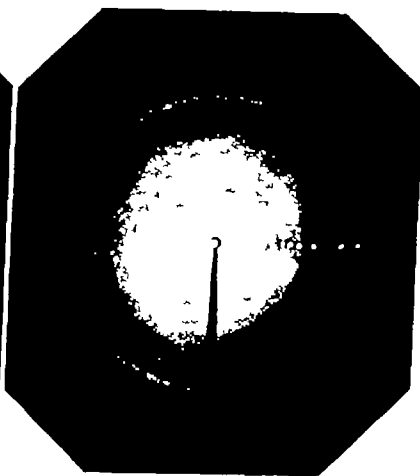


Fig 24

Fig 21 Diffraction pattern of formic acid extracted hemin

Fig 22 Acetic acid extracted hemin

Fig 23 Chlorohemin

Fig 24 Potassium oxyhemin

hemins prepared by extraction with alcoholic solutions of acetic and formic acids, although in solubility chlorohemin closely resembles the formic acid hemin

Chlorohemin can be recrystallized by dissolving it in a small amount of a pyridine-chloroform mixture and adding this to a hot solution of glacial acetic and sodium chloride It is readily soluble in a 2 per cent solution of KOH up to 10 per

oxyhemin (Fig 24), although the photomicrographs appear quite different due to the size of the potassium oxyhemin crystals

The interplanar spacings of chlorohemin and their relative intensities are given in Table II

(c) *Potassium Oxyhemin*—Although it is believed that potassium oxyhemin is merely the potassium salt of chlorohemin,

THE CIRCULAR LESION OF PULMONARY TUBERCULOSIS¹

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IN the course of study of a large number of chest roentgenograms, one occasionally observes sharply defined round or oval shaped areas of density, usually solitary, and seldom measuring more than four centimeters in diameter. Although in some instances they may be found together with smaller or larger exudative foci in the parenchyma of the lung, and may themselves be multiple, they are in most cases single foci situated in organs showing no other abnormality.

At first sight such circular areas of density resemble neoplastic metastases, but when a study is made of serial films obtained at intervals over a period of months or years, they are found to be remarkably inactive. It is only by obtaining a history strongly supporting tuberculous disease, or by observing excavations accompanied by dissemination of tuberculous infiltrations after a long period of inactivity, that the true nature of the circular lesion is finally established.

Interest in this type of tuberculous lesion dates back to 1925, when Assmann, who first called attention to it, found such isolated circular lesions in the infraclavicular region of the lung. He attributed these lesions to tubercle bacillus implantation and was emphatic in stating that they were not primary since he was not able to observe mediastinal lymph node enlargement associated with them. Following Assmann's first description other observers have contributed to the literature on this subject. In 1931, Albert advanced the opinion that the round foci represented encapsulated tuberculous lesions. A year later, Straub reported on eight cases which he had observed for comparatively long periods of time. He concluded that such foci were of no prognostic significance because he found that some of them could

undergo a change, often after a long period of apparent dormancy. He also believed that excavation would be more probable if the lesions that broke down were in direct communication with a bronchus. Straub's belief was that the round focus resulted from an exudative flare-up that later became isolated by connective tissue encapsulation. Klein and Wolff, in 1934, added six more cases to the accumulating literature, five of which showed inactivity of the round foci after one or two years. The other case, which terminated fatally, revealed a lesion which remained stationary for about six months, only to break down and become the cause of a spreading exudative tuberculosis.

This case afforded the autopsy material that showed the characteristic lesion to consist of a chalky caseous substance at its center, encircled by more centrally deposited loose connective tissue and a peripheral dense hyaline connective tissue capsule. This lesion was not considered to be a primary focus and was thought to have had its origin in the bronchus in the course of a bronchogenic spread.

For over five years our interest has been centered on the circular tuberculous focus, our chief purpose being to study its progress and to determine an effective method of treating it.

The 60 cases upon which the present report is based have been selected on the basis of their circular outline. The semi-circular and comma-shaped areas of density, so characteristic of the more commonly encountered signs of chronic tuberculosis, were not included in this collection. All cases chosen appear to be tuberculous, some having been so diagnosed by the finding of tubercle bacilli in the sputum, others by obtaining a definite history of contact, and still others showing positive tuberculin reactions.

Most of these cases have been observed for more than a year, some for periods of

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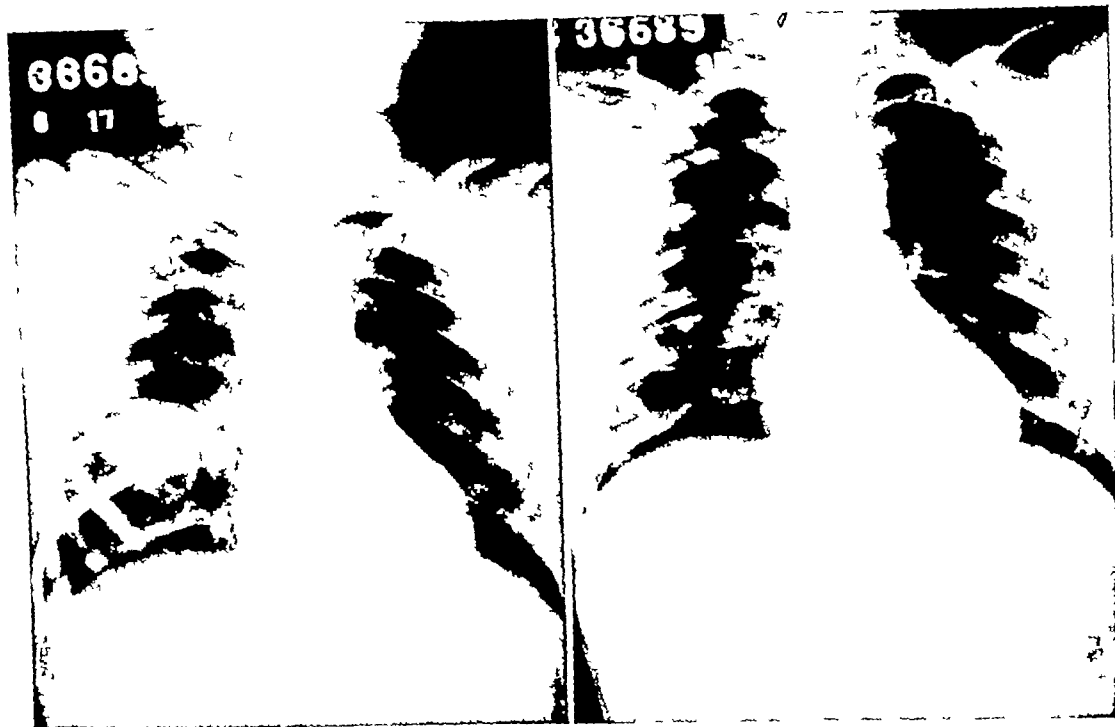


Fig 5

Fig 5 This is a receding childhood type of lesion described in Group III

Fig 6 The same as shown in Figure 5, about three years later

from five to six years, and a few for six months. While some of the circular lesions were observed to develop from originally diffuse tuberculous infiltration, others were circular at the time of first observation. A small group includes those which appear to represent the final stage of a primary or childhood type of infiltration. Contrary to the belief of the previous observers, it is felt that some circular lesions develop from first infection.

According to our observations, the circular lesions may be divided into the following three groups:

Group I—This group includes those lesions which have been found to develop from diffuse infiltration. Such lesions are not entirely stationary and may undergo excavation. Most of them, however, show a tendency to become smaller. In this group are included some cases showing other types of tuberculous foci in addition to the characteristic circular lesions. It has been found that the circular lesion is the least likely to play a part in the spread-

ing disease, but may itself show some change simultaneously with changes in the other foci. The lesions in this group, being very unstable, require more careful observation than those of the other two groups.

Group II—This group includes those lesions which are definitely circular when first discovered. They may be single or multiple, but, in most instances, they are solitary lesions varying in size from 0.5 to 3 cm in diameter. Most of them are of uniform density and well defined in outline, they are definitely in the parenchyma and not in the pleura as thought by some. Occasionally they excavate and may cause a spread of the tuberculous disease, but this is not usual. These lesions remain stationary for months and years. The lesions in Group II probably represent the well encapsulated type which is least likely to become active.

Group III—This group includes the receding stage of the childhood type of infiltration. At first, the lesions of this group have been found to be definitely circular,



Fig 1

Fig 2

Fig 1 This case illustrates the type of lesion described in Group I

Fig 2 Same case as shown in Figure 1 but three years later

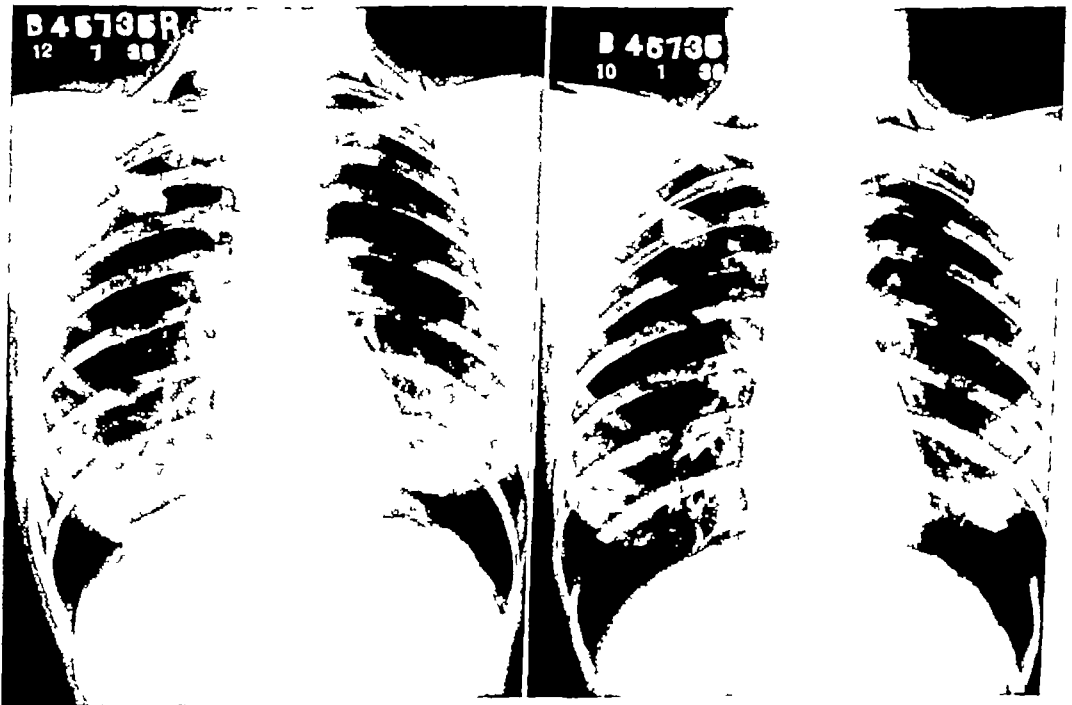


Fig 3

Fig 4

Fig 3 This is the type of lesion described in Group II

Fig 4 The same case as shown in Figure 3 but three years later

DISCUSSION

DR HENRY KENNON DUNHAM (Cincinnati, Ohio) I am very much pleased with this presentation and anything I may say must not be construed as criticism but approval. And yet, when the Doctor speaks of benign tuberculosis, that is a good deal like a red rag to a bull to me because I don't believe that any kind of tuberculosis that really is honest-to-God tuberculosis is benign.

It does get well sometimes—becomes arrested—but to classify any form of tuberculosis as benign—well, it's hard on my mentality.

The three groups of lesions which the essayist describes are clear.

The first group corresponds to the lesions which I originally described as fans. Pulmonary exudate has been absorbed and the repair tissue has contracted the residue into a spherical lesion.

Last Sunday at the Sanatorium we reviewed a case in which a spherical lesion had contracted around an arrested area of tuberculosis bronchopneumonia.

Thus, many spherical areas of increased pulmonary density can be explained by absorption of pulmonary exudate and contraction of scar tissue. Several such cases can be seen in the exhibit in the other rooms.

The other two groups are not so easily explained, understood, or diagnosed. Some of them, as the essayist has said, break down and are easily proved tuberculous. Those which do not are in question and I think it unsound to diagnose them tuberculous lesions. One fan or one density may be tuberculous but two or more such densities suggesting different age are necessary to clinch an x-ray diagnosis of tuberculosis. Certainly a positive tuberculin reaction with one such density is not enough upon which to base a diagnosis of tuberculosis.

I hope that these densities in the future will be described as spherical rather than circular because stereoscopically they can be seen to be round.

It is a pleasure to add Dr Ewing's name to the literature because he was the first to call to my attention these round lesions, some of which he had proven to be tuberculous. This was in 1916 or 1917.

The term "first infection" should, in my opinion, be called "first infections," because we do not know what infection was first. If we accept the definition of allergy given by Dr Krouse, then allergy begins when we have had enough first infections to create an allergic state. A positive tuberculin reaction may not indicate an allergic state. An allergic state has developed when an individual has had enough first infection to cause a new tuberculous infection to produce an inflammatory reaction at the point of inoculation.

Reinke's primary infection was a lesion of which we could have no clinical nor pathological proof but which existed nevertheless.

The point I wish you to consider is that when such terms as "first infection," "allergy," "hypersensitiveness," and "immunity" are used, we really require the author's definition before we can fully understand his diction.

DR BIRKELO (closing) I have very little to add except to thank Dr Dunham for his generous discussion. I knew I would get a good discussion from him.

I feel the same as he does about benignity of tuberculosis. I don't think there is such a thing but, relatively speaking, I think the circular lesion is the most benign tuberculous lesion I know anything about.

As far as the lesion being spherical, that is, perhaps, true, but we selected the other name because most of our work is done with flat films.

I didn't find anything in the literature written by Dr Ewing on this subject. I am not describing anything new. My purpose in taking up this subject was to attempt to standardize the treatment of this type of lesion.

later, they retrogressed without any collapse therapy. These lesions may be out of place in this discussion, but since they show circular outlines, they are included as part of the whole series of round lesions.

In the light of the observations made, it would appear that the lesions of Group II require only periodic check-up. In the event that excavation should begin, the indication would be for some therapeutic intervention. In this group, three showed evidence of excavation, while 36 remained inactive. The longest period of observation was six years and the shortest, eight months. The cases showing excavation were from among those that were observed for the longer period. However, the excavations in three cases led to complete disappearance of the lesion. Such cases could probably be considered as having their excavating foci in direct communication with bronchi, as suggested by Straub.

The lesions recorded in Group I represent incomplete healing with the possibility of incomplete encapsulation. Since the majority of the 16 cases recorded showed retrogression, it would be justifiable to conclude that their outlook for satisfactory recovery would be good, and that one might expect eventual disappearance of the lesion or complete encapsulation. However, this type of lesion bears more careful observation than that falling in Group II of this classification.

Phrenic surgery was often employed as a precautionary measure. Very few of these cases required pneumothorax and none had to be subjected to thoracoplasty. This group, with the ultimate tendency to encapsulation of their lesions, under no other therapeutic regimen than bed rest, represent the so-called benign type of tuberculosis.

For the third group of cases, namely, those in which the lesions are of the child-

hood type, no additional suggestions can be advanced, except to emphasize that continued observation of the lesions is a necessity.

SUMMARY

(1) Circular tuberculous lesions in the lungs represent definite types which may be classified into three groups.

(2) The three groups outlined are based upon the mode of development.

(3) The lesions in Group I are found to develop in areas previously showing exudative infiltration, having no definite outline and not of the childhood type. This type of lesion requires more careful observation and proportionately more collapse therapy than lesions of the other two groups.

Group II consists of lesions with definite circular outline when first observed. They may be solid or excavating, but, in the majority of instances, they are very stable and require no collapse therapy.

Group III originates from the primary focus and shows the usual tendency to decrease in size.

(4) Such lesions represent a type of healing in which fibrous encapsulation is the outstanding feature of the pathologic process.

(5) Although circular lesions cannot yet be considered helpful in foretelling the ultimate outcome of the tuberculous lesion, they may be looked upon as being indicative of a relatively benign type of pulmonary tuberculosis.

(6) This report is based on a study of 60 cases and includes 16 in Group I, 39 in Group II, and 5 in Group III.

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THERAPEUTIC RESULTS ACCORDING TO GROUPS

Type	No of Cases	Phrenic	Pneumothorax	No Treatment	Increase	Decrease	Stationary
I	16	6	4	9	2	8	6
II	39	13	3	26	3	9	27
III	5	0	0	5	0	5	0

When pieces of Mouse Sarcoma 180, each weighing about 6 mg, and measuring about (2 mm)³ are inoculated subcutaneously in the lateral thoracic region by trocar, many of these transplants grow in spherical or in ovoid form, becoming flattened on their deeper aspect during the first week. As the tumors grow larger, many of them develop pressure necrosis at the subcutaneous parts of the tumors as early as the second week, and subsequently cause the deaths of the animals from toxemia, septicemia, and nutritional failure in about three weeks from the time of transplantation (Fig 1, Nos 4, 5, 6, 7). Some of the large tumors ulcerate, become infected and slough, and eventually regress and disappear completely (Fig 1, Nos 10, 11), while others grow normally for two to three weeks and then regress (Fig 1, Nos 12, 13, 14). The former cases we call spontaneous cures, and the latter cases, spontaneous regressions. All of these cases are considered as positive "takes." However, in a case like No 14, in which the transplant grew very rapidly for two weeks and then absorbed, one must ascertain whether or not the apparent growth is due to inflammatory reaction or to a true tumor. If the growth is inflammatory in nature, it should not be included as a positive take. Some transplants proliferate in the animals for several days, and then regress and are absorbed. If they are completely absorbed within two or three weeks, they are considered as negative transplants (Fig 1, Nos 15, 16).

Subcutaneous inoculations of tumor into healthy young adult white mice, males and females, weighing generally from 23 to 30 gm, were carried out by the usual trocar method, the tumor materials being selected from rapidly growing tumors which had not ulcerated. The tumors were about two weeks old (Fig 1, Nos 1, 2). The animals were fed upon Purina laboratory chows and lettuce, with as much fresh water as they would take.

During the past six months we had made over 600 normal tumor implantations and

found that in the majority of the series the tumor "takes" were 100 per cent and seldom below 90 per cent, the average takes being 99 per cent. The transplants showed occasional spontaneous regression, such cases representing about 4 per cent of the positive growths. However, spontaneous absorption (spontaneous cure + spontaneous regression) was about 11 per cent.

EFFECT OF ROENTGEN RAYS ON THE HEALTH OF WHITE MICE

As a preliminary study, we have determined the amount of radiation tolerated by the mouse when given as a single massive dose.

Young healthy adult white mice, males and females, weighing generally from 23 to 30 gm, were fastened on a stiff pasteboard, two at a time as shown in Figure 2. In this manner the mice remained in a fixed position during the irradiation with their backs touching the pasteboard.

The radiation was supplied by a standard water-cooled Coolidge roentgen tube under the following conditions: 200 kv, 30 ma, 0.5 mm copper, and 1.6 mm aluminum filter, 50 cm distance from the target to the ventral skin surface of the body. At this point, the intensity of the beam measured in air was found to be 59 roentgens per minute.

A careful record was kept of the physical condition, body weight, and the duration of life of these irradiated mice. The biological effects of the filtered roentgen rays on mice may be briefly summarized as follows. A dose of 250 r or less had no harmful influence upon the nutrition of the mice. The animals grew normally and maintained excellent health during the experimental period of about two months. Doses of 350 and 400 r generally prevented gain in body weight. Some lost weight slightly during the first two weeks, but maintained their weight thereafter. With the former dose none died, but with the latter dose 18 per cent of animals died. With a dose of 500 r, the animals lost weight and 71 per cent of them died, some

THE EFFECT OF ROENTGEN RAYS ON THE GROWTH OF MOUSE SARCOMA 180 IRRADIATED *IN VIVO*

By KANEMATSU SUGIURA, D M Sc , *New York City*

From the Huntington Fund for Cancer Research, Memorial Hospital

IN a previous study (1) the effect of 200 kv roentgen rays on Mouse Sarcoma 180 *in vitro* was investigated. It was found that the viability of the mouse sarcoma was completely destroyed by an exposure to a dose of about 2,800 roentgens of filtered roentgen rays.

It was further shown in this institution that the injurious action of filtered roentgen rays on the proliferating capacity of sarcoma cells was decidedly increased when the tumor tissues were irradiated upon the surface of a paraffin phantom. The back-scatter obtained by this method was found to be 30 per cent (2). Later we measured the depth dose by means of the transplantable tumor, using a paraffin phantom. The percentage depth dose at 2, 6 7, and 9 8 cm was found to be 97, 86, and 54, respectively (2). These values agree reasonably well with the depth doses determined by ionization measurements made under similar conditions.

In the irradiation of the tumor tissues *in vitro*, they are completely isolated from the surrounding normal tissues, blood vessels, tissue fluid, etc. Therefore, it is possible to observe the direct action only. However, from studying the biological effects of roentgen rays *in vivo* and comparing the results with those obtained by experiments *in vitro*, it may be possible to calculate the extent of the direct and indirect actions of radiation upon living cells. The following experiments were carried out with the object of testing this supposition.

MATERIALS AND METHODS

The Mouse Sarcoma 180 was selected for the present study, the behavior of which in mice has been reported elsewhere. It may be of interest, however, to summarize its manner of development, since this may have a bearing upon the present

investigation. A graphic illustration of a number of more or less typical examples of the progress of normal tumor implants in animals may show this development clearly (Fig 1).

Normal Growth of Mouse Sarcoma 180

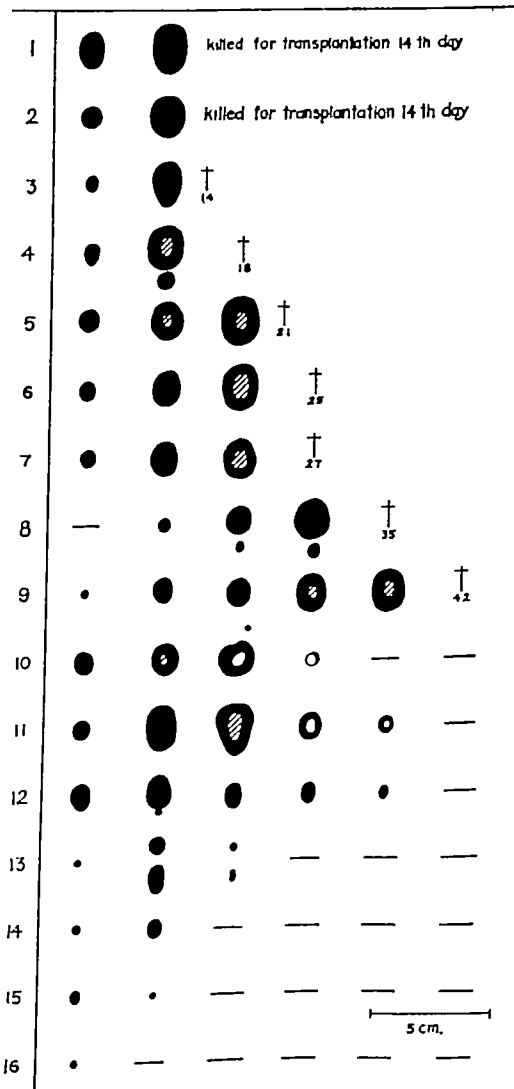


Fig 1 Progress of normal tumor implants in white mice.

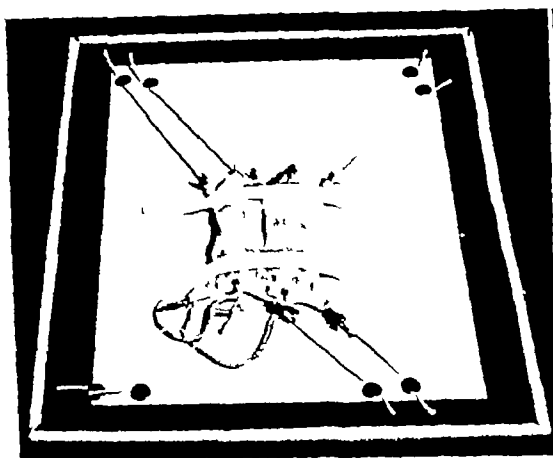


Fig 2

Fig 2 Method of fastening mice to animal board for irradiation

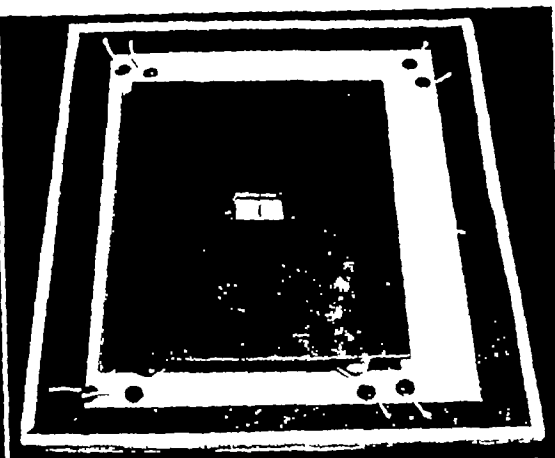


Fig 3

Fig 3 Two tumors were irradiated *in vivo* through a hole slightly larger than the cross section of the tumor in a lead shield 5 mm thick

tumors are denoted by the measurements of lengths, widths, and thicknesses. In the table the complete absorption of the tumors is indicated by a plus sign (+) in the fifth column, while the continuation of tumor growth is indicated by a minus sign (-). In the last column we have given a brief account of the behavior of the irradiated tumors. The data are arranged according to the decreasing duration of tissue exposure.

It will be seen that the destruction of the malignant growths was easily accomplished by the radiation from filtered roentgen rays. A dose of 1,480 r or over regularly produced a definite inhibition in the growth of the Mouse Sarcoma 180 and subsequently complete retrogression in about twenty-four days. Even in many of the negative cases, the tumors remained stationary during the first two weeks after irradiation, but later resumed normal growth and killed the hosts, or ulcerated and disappeared.

It may be of interest to mention that the irradiated tumor actually increased in size during the first week after irradiation, even with a large dose of 1,500-3,000 r. The enlargement of the tumor tissue may have been due merely to edema rather than to actual cell proliferation. Histologic

examination of a number of the irradiated tumor tissues revealed numerous swollen cells and intercellular edema.

Progressively growing tumors are colored light pink, after irradiation, the color changes to a deep purple, while subsequently the tumor becomes gradually pale and bloodless. During this period it is decreasing in size.

None of the 74 animals cured of their tumors by roentgen rays showed local recurrences. A small number of cured animals showed tumors along the course of the trocar insertion (an area well protected from radiation by the lead shield) some days after irradiation. These tumors either continued to grow normally, or regressed completely, the regression often paralleling that of the irradiated primary tumor.

The following reactions were produced in the skin. With doses of from 100 to 750 r, there was no epilation. With a dose of 1,000 r, no changes were visible for the first six weeks after exposure, but toward the end of the seventh week a slight epilation of the irradiated area occurred. With a dose of 1,500 r, partial epilation occurred at the fifth week, followed by a gradual return of hair. Doses from 1,770 to 3,540 r showed a gradual increase in the complete-

as early as the ninth day, others lived during the experimental period of about two months. However, when a dose of 750 r or more was given, all animals showed marked nutritional disturbance, continued loss of body weight, and all died within 18 days, the shortest interval being the third day, this following a dose of 1,000 r or over.

TABLE I—EFFECT OF ROENTGEN RAYS (200 KV, 30 MA, 0.5 MM CU + 1.6 MM AL FILTER) UPON THE HEALTH OF WHITE MICE

No Animals Used	Dose in Roentgens	Remarks
6	2830	2 mice died on third day, 4 mice died on fourth day
8	1500	2 mice died on third day, 4 mice died on fourth day, 2 mice died on fifth day
12	1000	4 mice died on third day, 2 mice each died on fourth, fifth, sixth and eighth day
16	750	2 mice each died on ninth, tenth, twelfth, and eighteenth day, 4 mice each died on thirteenth and fourteenth day
21	500	2 mice each died on ninth, thirteenth, and fourteenth day, 4 mice each died on tenth and eleventh day, 1 mouse died on nineteenth day, 6 mice survived
22	400	2 mice died on fourteenth day, 1 mouse each died on twentieth and twenty fifth day, 18 mice survived
12	350	All survived
10	250	All survived
11	100	All survived

EFFECT OF ROENTGEN RAYS ON MOUSE SARCOMA 180

The foregoing experiments showed the effect of radiation on the entire body of the animal whose total body volume¹ was approximately 28 cc. With these conditions a dose of 350 r did not kill any mice, with a dose of 400 r, 18 per cent of mice died. As irradiation continued the lethal effect on mice greatly increased. Thus the doses of 500 and 750 r produced 71 and 100 per cent lethal results, respec-

tively. Therefore, a dose of 400 r is just about on the borderline between the lethal and sub-lethal.

When the area irradiated is about 2.9 sq cm, so that a limited volume of the body, 4.8 cc, is irradiated on the right or left lateral thoracic region, then the dosage can be increased to about 3,000 r without much nutritional disturbance. Some animals, however, died from x-ray anemia some weeks after irradiation.

The experimental procedure was as follows. Fragments of Mouse Sarcoma 180 were inoculated subcutaneously into young adult mice in the right or left lateral thoracic region by trocar. When tumor grafts had grown from six to ten days to establish a suitable size, they were submitted to roentgen-ray irradiation. Two tumor-bearing animals were fastened side by side on a stiff pasteboard as shown in Figure 2. A specially constructed lead shield 5 mm thick with celluloid 1 mm thick attached, and having a hole 2 × 2.9 cm in the center, was then placed over these animals with their ventral hair touching the celluloid as shown in Figure 3. In this way all parts of the animal except the tumor and its surrounding normal tissues were protected from radiation. Then the pasteboard holding the tumor-bearing animals was placed directly under the roentgen tube with a target-skin distance of 50 cm, and subjected to radiation under the conditions previously described, intensity being 59 r per minute. The absorption of radiation through 0.3 mm thickness of skin and hair of a mouse is negligible in this case.

The development of the tumors in the animals was recorded graphically by measuring them every week by means of calipers.

The results obtained from irradiation of mouse sarcomas of various sizes are presented in Table II. In this table are included all observations, positive and negative, in the hope of finding the minimum lethal dose expressed in roentgens for the Mouse Sarcoma 180 in animals. In the second column of the table the sizes of the

¹ The total body volume was determined by submerging the entire body in water contained in a small graduated cylinder.

TABLE II-B—EFFECT OF ROENTGEN RAYS (200 KV, 30 MA, 0.5 MM CU + 1.6 MM —BL FILTER) UPON THE GROWTH OF MOUSE SARCOMA 180 IN ANIMALS

No of Animal	Dimensions of Tumor (mm)	Duration of Exposure (minutes)	Dose in Roentgens	Results of Irradiation	Remarks
1	10.5 × 10 × 7	60	3.540	+	Tumor rapidly retrogressed, complete absorption in 21 days
2	6.5 × 6 × 5	60	3.540	+	Tumor slowly retrogressed, complete absorption in 33 days
3	4.7 × 4.5 × 3	55	3.240	+	Tumor rapidly retrogressed, complete absorption in 21 days
4	7 × 7 × 5	55	3.240	+	Tumor rapidly retrogressed, complete absorption in 21 days
5	5.4 × 4.5 × 2	55	3.240	+	Tumor rapidly retrogressed, complete absorption in 19 days
6	15.2 × 12 × 8	55	3.240	+	Tumor slowly retrogressed, complete absorption in 30 days
7	4 × 4.5 × 3	48	2.830	+	Tumor rapidly retrogressed, complete absorption in 21 days
8	10.5 × 6.5 × 5	48	2.830	+	Tumor slowly retrogressed, complete absorption in 29 days
9	10.8 × 8.5 × 7	48	2.830	+	Tumor slowly retrogressed, complete absorption in 35 days
10	3.1 × 2.5 × 2	48	2.830	+	Tumor rapidly retrogressed, complete absorption in 18 days
11	6.5 × 5.5 × 3	48	2.830	+	Tumor rapidly retrogressed, complete absorption in 21 days
12	3.2 × 2.2 × 1	48	2.830	+	Tumor slowly retrogressed, complete absorption in 25 days
13	3.8 × 2.3 × 2	48	2.830	+	Tumor rapidly retrogressed, complete absorption in 14 days
14	4.8 × 5 × 3	48	2.830	+	Tumor slowly retrogressed, complete absorption in 30 days
15	10 × 9 × 7	48	2.830	+	Tumor rapidly retrogressed, complete absorption in 21 days
16	10.5 × 9 × 8	48	2.830	+	Tumor slowly retrogressed, complete absorption in 35 days
17	7.2 × 6.5 × 4	48	2.830	+	Tumor slowly retrogressed, complete absorption in 28 days
18	5.1 × 5 × 4	48	2.830	+	Tumor rapidly retrogressed, complete absorption in 21 days
19	7 × 6.5 × 3	48	2.830	+	Tumor rapidly retrogressed, complete absorption in 14 days
20	11.5 × 9.5 × 7	48	2.830	+	Tumor slowly retrogressed, complete absorption in 30 days
21	4 × 3 × 2	48	2.830	+	Tumor rapidly retrogressed, complete absorption in 19 days
22	3.5 × 2.8 × 2	48	2.830	+	Tumor rapidly retrogressed, complete absorption in 15 days
23	9.5 × 7.8 × 5	43	2.540	+	Tumor rapidly retrogressed, complete absorption in 21 days
24	8.1 × 7.5 × 5	43	2.540	+	Tumor slowly retrogressed, complete absorption in 28 days
25	15.2 × 12 × 8	43	2.540	+	Tumor slowly retrogressed, complete absorption in 35 days
26	8.9 × 7.4 × 5	43	2.540	+	Tumor slowly retrogressed, complete absorption in 28 days
27	5.2 × 4.5 × 3	43	2.540	+	Tumor rapidly retrogressed, complete absorption in 21 days
28	5.8 × 3.1 × 2	43	2.540	+	Tumor rapidly retrogressed, complete absorption in 14 days
29	7.2 × 6.5 × 4	34	2.000	+	Tumor rapidly retrogressed, complete absorption in 21 days
30	8.5 × 7 × 5	34	2.000	+	Tumor rapidly retrogressed, complete absorption in 21 days
31	10 × 8 × 6	34	2.000	+	Tumor slowly retrogressed, complete absorption in 28 days
32	4.5 × 3 × 1.5	34	2.000	+	Tumor slowly retrogressed, complete absorption in 25 days
33	7.2 × 4.5 × 2	34	2.000	+	Tumor rapidly retrogressed, complete absorption in 21 days

+ indicates cure of tumor, — indicates continued growth of tumor
(Cont'd on next page)

ness of the epilation, permanent in some cases, but temporary in others. Under the stated condition of irradiation neither necrosis nor ulceration of the skin was produced.

In an attempt to establish a minimum curative dose in roentgens for the Mouse Sarcoma 180 *in vivo* the results presented in Table II are grouped as in Table II-A. From this arrangement it is evident that no tumor regressed with a minimum dose of less than 500 r, and very few with less than 750 r. With a dose of 1,000 r, about half of the cases showed regressions. With more than 1,500 r, regression occurred in almost 100 per cent of cases in which the masses were not more than 1.5 cm in diameter. A graphic illustration of a number of more or less typical examples of the progress of irradiated and non-irradiated tumors may show this point more clearly (Fig. 4).

The Effect of Roentgen Rays on the Growth of Mouse Sarcoma 180 irradiated *in vivo*

No. of Mouse	Roentgens	0	7	14	21	28	35	42 Days
8	2830	●	●	●	●	—	—	—
31	2000	●	●	●	●	—	—	—
35	2000	●	●	●	—	—	—	—
47	1500	●	●	●	●	●	—	—
58	1480	●	●	●	—	—	—	—
77	1000	●	●	●	—	—	—	—
85	1000	●	●	●	●	●	●	●
110	500	●	●	●	●	●	●	—
117	250	●	●	†	—	—	—	—
125	100	●	●	●	†	—	—	—
C	0	●	●	†	—	—	—	—
C	0	●	●	●	†	—	—	—

Fig. 4. The proliferating capacity of Mouse Sarcoma 180 was completely inhibited with a dose of 1,500 r or more. On the other hand, a dose of 1,000 r or less was insufficient for the complete destruction of the sarcoma. Age of these tumors was seven days. C represents unirradiated tumors.

In connection with the present study, a number of observations were made with Mouse Sarcoma 180 fragments irradiated in air to determine whether or not the radiosensitivity of the tumor had remained the same as had previously been determined.

This study included three groups of experiments, involving a total of 96 implants. The apparatus, materials, technique, and the conditions of irradiation were the same as those previously described.

The results obtained from this procedure showed that 48 minutes' exposure (about 2,830 r) of the tumor fragments to filtered radiation prevented 83 per cent of them from growth (average of 60, 90, and 100 per cent inhibition) instead of 100 per cent as in previous experiments (1, 2). Since biological experiments of this sort are subject to experimental errors of considerable magnitude, it is not possible at present to state that the difference is significant. The viability of the transplants, however, was completely destroyed by 49.5 and 51 minutes' exposure (about 2,920 and 3,000 r) in the present study.

TABLE II-A—RESULTS OF IRRADIATION OF TUMORS 1.5 CENTIMETERS OR LESS IN DIAMETER (6 TO 10 DAYS IN AGE) *IN VIVO*

Dose in Roentgens	Positive Reaction	Negative Reaction	Percentage of Cure
100	0	8	0
250	0	8	0
500	0	18	0
750	2	8	20
1,000	6	6	50
1,060	4	4	50
1,480	11	1	92
1,500	7	2	78
1,770	6	2	75
2,000	10	0	100
2,540	6	0	100
2,830	16	0	100
3,240	4	0	100
3,540	2	0	100

DISCUSSION

In comparing the results obtained from experiments *in vitro* and *in vivo* with a transplantable mammalian tumor it will be noted that the lethal dose for Mouse Sarcoma 180 *in vitro* for well-filtered roent-

No of Animal	Dimensions of Tumor (mm)	Duration of Exposure (minutes)	Dose in Roentgens	Results of Irradiation	Remarks
71	25 × 25 × 1	18	1,060	+	Tumor slowly retrogressed, complete absorption in 28 days
72	122 × 53 × 3	18	1,060	—	Tumor continued to grow
73	4 × 27 × 2	18	1,060	—	Tumor continued to grow
74	65 × 5 × 3	18	1,060	—	Tumor continued to grow
75	7 × 5 × 3	18	1,060	—	Tumor continued to grow
76	65 × 43 × 3	17	1,000	+	Tumor rapidly retrogressed, complete absorption in 21 days
77	62 × 52 × 3	17	1,000	+	Tumor slowly retrogressed, complete absorption in 22 days
78	60 × 58 × 35	17	1,000	+	Tumor slowly retrogressed, complete absorption in 39 days
79	115 × 75 × 5	17	1,000	+	Tumor slowly retrogressed, complete absorption in 35 days
80	9 × 67 × 5	17	1,000	+	Tumor slowly retrogressed, complete absorption in 24 days
81	5 × 5 × 2	17	1,000	+	Tumor rapidly retrogressed, complete absorption in 21 days
82	35 × 27 × 2	17	1,000	—	Tumor continued to grow
83	62 × 51 × 3	17	1,000	—	Tumor continued to grow
84	49 × 5 × 25	17	1,000	—	Tumor continued to grow
85	67 × 65 × 5	17	1,000	—	Tumor continued to grow
86	94 × 75 × 5	17	1,000	—	Tumor continued to grow
87	4 × 4 × 3	17	1,000	—	Tumor continued to grow
88	64 × 43 × 35	12 7	750	+	Tumor slowly retrogressed, complete absorption in 29 days
89	68 × 65 × 4	12 7	750	+	Tumor slowly retrogressed, complete absorption in 28 days
90	49 × 5 × 3	12 7	750	—	Tumor continued to grow
91	7 × 55 × 4	12 7	750	—	Tumor continued to grow
92	73 × 55 × 3	12 7	750	—	Tumor continued to grow
93	62 × 55 × 3	12 7	750	—	Tumor continued to grow
94	48 × 4 × 3	12 7	750	—	Tumor continued to grow
95	72 × 64 × 4	12 7	750	—	Tumor continued to grow
96	7 × 62 × 4	12 7	750	—	Tumor continued to grow
97	32 × 25 × 2	12 7	750	—	Tumor continued to grow
98	4 × 32 × 2	8 5	500	—	Tumor continued to grow
99	52 × 48 × 3	8 5	500	—	Tumor continued to grow
100	58 × 53 × 4	8 5	500	—	Tumor continued to grow
101	7 × 63 × 4	8 5	500	—	Tumor continued to grow
102	75 × 45 × 3	8 5	500	—	Tumor continued to grow
103	7 × 65 × 4	8 5	500	—	Tumor continued to grow
104	5 × 5 × 3	8 5	500	—	Tumor continued to grow
105	35 × 3 × 2	8 5	500	—	Tumor continued to grow
106	55 × 52 × 4	8 5	500	—	Tumor continued to grow
107	65 × 55 × 3	8 5	500	—	Tumor continued to grow
108	54 × 51 × 25	8 5	500	—	Tumor continued to grow
109	65 × 5 × 25	8 5	500	—	Tumor continued to grow
110	71 × 7 × 4	8 5	500	—	Tumor continued to grow
111	61 × 64 × 3	8 5	500	—	Tumor continued to grow
112	62 × 48 × 3	8 5	500	—	Tumor continued to grow
113	74 × 5 × 4	8 5	500	—	Tumor continued to grow
114	28 × 22 × 2	8 5	500	—	Tumor continued to grow
115	4 × 4 × 2	8 5	500	—	Tumor continued to grow
116	8 × 6 × 4	4 2	250	—	Tumor continued to grow
117	73 × 47 × 3	4 2	250	—	Tumor continued to grow
118	72 × 42 × 2	4 2	250	—	Tumor continued to grow
119	3 × 22 × 1	4 2	250	—	Tumor continued to grow
120	62 × 6 × 4	4 2	250	—	Tumor continued to grow
121	58 × 5 × 3	4 2	250	—	Tumor continued to grow
122	3 × 25 × 1	4 2	250	—	Tumor continued to grow
123	8 × 62 × 4	4 2	250	—	Tumor continued to grow
124	62 × 44 × 3	1 7	100	—	Tumor continued to grow
125	7 × 62 × 4	1 7	100	—	Tumor continued to grow
126	58 × 31 × 2	1 7	100	—	Tumor continued to grow
127	3 × 22 × 1	1 7	100	—	Tumor continued to grow
128	35 × 3 × 2	1 7	100	—	Tumor continued to grow
129	72 × 68 × 3	1 7	100	—	Tumor continued to grow
130	35 × 35 × 2	1 7	100	—	Tumor continued to grow
131	72 × 7 × 4	1 7	100	—	Tumor continued to grow

No of Animal	Dimensions of Tumor (mm)	Duration of Exposure (minutes)	Dose in Roentgens	Results of Irradiation	Remarks
34	4.5 × 3.7 × 2	34	2,000	+	Tumor rapidly retrogressed, complete absorption in 21 days
35	3.5 × 2 × 1	34	2,000	+	Tumor rapidly retrogressed, complete absorption in 18 days
36	6 × 5.5 × 3	34	2,000	+	Tumor rapidly retrogressed, complete absorption in 19 days
37	4.8 × 3.5 × 2	34	2,000	+	Tumor slowly retrogressed, complete absorption in 33 days
38	14.5 × 9.7 × 7	34	2,000	+	Tumor rapidly retrogressed complete absorption in 35 days
39	6.2 × 6.4 × 2	30	1,770	+	Tumor rapidly retrogressed, complete absorption in 21 days
40	7.8 × 5 × 2.5	30	1,770	+	Tumor rapidly retrogressed complete absorption in 21 days
41	5.5 × 5.3 × 4	30	1,770	+	Tumor slowly retrogressed, complete absorption in 29 days
42	8 × 7 × 5	30	1,770	+	Tumor slowly retrogressed, complete absorption in 35 days
43	10.9 × 9 × 7	30	1,770	+	Tumor slowly retrogressed, complete absorption in 28 days
44	7.5 × 6.5 × 3	30	1,770	+	Tumor rapidly retrogressed, complete absorption in 21 days
45	6.5 × 6.4 × 5	30	1,770	-	Tumor growth stopped for 12 days then normal growth
46	3.5 × 2.5 × 2	30	1,770	-	Tumor growth stopped for 14 days, then normal growth
47	11 × 7.3 × 5	25 4	1,500	+	Tumor slowly retrogressed, complete absorption in 30 days
48	6.2 × 5.5 × 2.5	25 4	1,500	+	Tumor rapidly retrogressed, complete absorption in 21 days
49	7.8 × 7.5 × 4	25 4	1,500	+	Tumor rapidly retrogressed complete absorption in 21 days
50	8.1 × 7.2 × 5	25 4	1,500	+	Tumor slowly retrogressed, complete absorption in 28 days
51	8.2 × 8 × 5	25 4	1,500	+	Tumor slowly retrogressed, complete absorption in 28 days
52	5 × 4 × 2	25 4	1,500	+	Tumor rapidly retrogressed, complete absorption in 21 days
53	6.5 × 5.8 × 3	25 4	1,500	+	Tumor rapidly retrogressed complete absorption in 18 days
54	6.5 × 6.2 × 4	25 4	1,500	-	Tumor continued to grow
55	9 × 7.5 × 4	25 4	1,500	-	Tumor continued to grow
56	3.1 × 2.5 × 1	25	1,480	+	Tumor rapidly retrogressed, complete absorption in 14 days.
57	5.5 × 5.5 × 3	25	1,480	+	Tumor rapidly retrogressed complete absorption in 21 days.
58	6.5 × 5.2 × 3	25	1,480	+	Tumor slowly retrogressed, complete absorption in 26 days.
59	10 × 7.5 × 6	25	1,480	+	Tumor slowly retrogressed, complete absorption in 28 days
60	7.8 × 7 × 5	25	1,480	+	Tumor rapidly retrogressed complete absorption in 21 days
61	9.5 × 7.3 × 6	25	1,480	+	Tumor rapidly retrogressed complete absorption in 21 days
62	8.5 × 7 × 4	25	1,480	+	Tumor slowly retrogressed complete absorption in 28 days
63	7.2 × 5 × 3	25	1,480	+	Tumor rapidly retrogressed complete absorption in 21 days
64	3 × 3 × 2	25	1,480	+	Tumor rapidly retrogressed complete absorption in 14 days
65	3.5 × 3 × 2	25	1,480	+	Tumor rapidly retrogressed complete absorption in 14 days
66	4.7 × 4.5 × 3	25	1,480	+	Tumor rapidly retrogressed complete absorption in 21 days
67	4.5 × 4.5 × 3	25	1,480	-	Tumor continued to grow
68	3.5 × 3.1 × 2	18	1,060	+	Tumor rapidly retrogressed, complete absorption in 14 days.
69	5 × 4.2 × 2	18	1,060	+	Tumor slowly retrogressed complete absorption in 47 days
70	9 × 6.2 × 4	18	1,060	+	Tumor slowly retrogressed complete absorption in 28 days.

(Cont'd on next page)

appear in the irradiated area grew at a much slower rate than the controls. However, when untreated tumor tissues were implanted in the irradiated area seven days after irradiation, not only was the number of tumor takes greatly increased (almost 100 per cent), but the rate of tumor growth was almost normal.

This work is being continued and extended to include a study of the rate of recovery of tissues after irradiation, *i.e.*, recuperation of tissues from the damage caused by radiation as shown by their susceptibility to tumor transplants.

SUMMARY

1 The effect of 200 kv roentgen rays on Mouse Sarcoma 180 in animals has been studied. Tumors, 0.3 to 1.5 cm in diameter, were irradiated *in vivo* through a hole slightly larger than the cross-section of the tumor in a lead shield 5 mm thick.

2 No tumor regressed with a dose of less than 500 roentgens, and very few with less than 750 roentgens. With a dose of 1,000 roentgens, about half of the cases showed complete regression, but with a dose greater than 1,500 roentgens, tumor regression occurred in almost 100 per cent of cases.

3 The radiosensitivity of Mouse Sarcoma 180 *in vitro* and *in vivo* has been compared. It was found that the lethal dose for the tumor growing in the animal was found to be about half of the dose required to destroy the viability of the same tumor *in vitro*.

I wish to express my thanks to Dr G. Failla for his co-operation and valuable suggestions during the course of the present study.

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gen rays is between 2,800 and 3,000 r, while the lethal dose for the same tumor *in vivo* is found to be about 1,500 r

The present results are in accord with the findings of Murphy, Maisin, and Sturm (3), who, working with spontaneous mammary cancer in mice found that 48 out of 50 grafts which were subjected to an erythema dose of x-rays *in vitro* grew progressively when inoculated intracutaneously in the original animals, or 96 per cent growth. On the other hand, when untreated grafts which had grown for about ten days in the original animals, were given a like dose of x-rays *in situ*, there followed a prompt disappearance of the tumor in 38 of 50 mice (76 per cent). It has been shown by Russ and Scott (4) that the cell-free filtrate of the Rous chicken sarcoma is very resistant to x-rays when the exposure is made *in vitro*. Even five times the lethal dose for Jensen rat sarcoma, Twort mouse carcinoma and Mouse Sarcoma 180 was unable to affect the infectivity of the extract. But Mottram (5) has pointed out that when the Rous chicken sarcoma is growing in the animal, exposure to the beta rays of radium will bring about disappearance of these tumors with doses not much greater than those necessary to bring about disappearance of rat and mouse tumors.

Such wide differences in radiosensitivity would indicate that the destructive effect of radiation upon tumors *in vivo* is due to a combination of direct action on the tumor cells, and the reaction of the surrounding tissues.

In this connection it is of great importance to mention the findings of Ewing with human material (6). Ewing states

"It is clear that the reaction of the tissues is an essential factor in the curative process. Under some circumstances, when this reaction fails, no amount of radiation succeeds in killing the tumor cells. The most detailed knowledge we possess indicates clearly that the curative action is not the result of a direct effect exclusively upon the tumor cells, but involves especially a peculiar reaction of the normal or invaded tissues."

In order to ascertain whether or not the increased radiosensitivity of tumor cells *in vivo* is due to the effect of scattered radiation the following experiments were made.

When tumor grafts had grown for about seven days in animals, they were irradiated with a dose of 2,830 r or 1,500 r in the same manner as that previously described. At the end of definite intervals of time the irradiated tumors were removed from the animals and tumor fragments were inoculated into normal animals in the usual way. It was found that none of the tumors which were extirpated immediately after irradiation with a dose of 2,830 r grew in animals. On the other hand, if the tumors were irradiated with a dose of 1,500 r, then removed immediately and inoculated into normal animals, they grew progressively in about 80 per cent as in the case of tumor fragments irradiated *in vitro* with the same dose of roentgen rays. But, if the irradiated tumors were allowed to remain in the irradiated area of animals for twenty-four hours, then removed and inoculated into normal animals, about 50 per cent of them produced growth. The viability of the irradiated tumors showed a gradual decrease upon remaining in the hosts. Thus when irradiated tumors (with a dose of 1,500 r) were removed from animals five days after irradiation and inoculated into normal animals, there followed only 20 per cent takes, while complete inhibition occurred if the irradiated tumors had remained in the hosts seven days or longer before re-implantation.

In the course of the investigation we also have determined the transplantability of Mouse Sarcoma 180 into irradiated areas in mice. A small portion of the body of a mouse was irradiated with a dose of 1,500 r and at the end of definite intervals of time untreated tumor fragments were inoculated into the irradiated area. It was found that a high percentage of tumor transplants failed to grow if the implantation was done within two hours after irradiation, while those which did not dis-



Fig 2 Practically all of spongy bone has been removed from vertebra A and cavity filled with paraffin No roentgen ray evidence of same



Fig 3 Upper figure shows an area of cortical bone one centimeter square removed from one lateral wall of vertebral body Lower figure after filling space with paraffin, still shows changes present on roentgenogram indicating that cortical bone is responsible for most of detail depicted on the film

we removed a V-shaped section of bone from the vertebral bodies of all patients dying of malignancy when autopsy was permitted To avoid distortion due to the spine-film distance or to the superimposed shadows, we sawed the spinal column lengthwise in the sagittal plane and placed one-half directly on the film holder, even under these conditions the larger areas of destruction were not demonstrable on the film

It is surprising how frequently metastatic malignancy is present in the vertebræ without clinical signs and without evidence on roentgenograms that have excellent detail and quality

By merely taking a wedge of bone about one-half centimeter in thickness from the lumbar vertebræ we found several cases of metastatic malignancy originating from primary carcinoma of the liver, tongue, stomach, gall bladder, urinary bladder, pancreas, rectum, and other organs supposed to metastasize but rarely to the os-

seous structures The largest number of metastases to the vertebræ was secondary to breast and prostatic carcinoma The best method of study would be that suggested by Fraenkel, in 1899, of sectioning and roentgenographing all bones of the body The fact that Fraenkel (1) found eight instances of metastasis to the vertebræ in the first 39 cases of gastric carcinoma he studied, indicates the correctness of his suggestion Time, finances, and permits many of us from adopting Fraenkel's method However, by using a heavy butcher knife and a hammer, a wedge of bone can be easily and quickly removed from the anterior portion of the vertebral column, and with little mutilation of the corpse The lumbar area is the most frequent site of metastasis to the vertebræ and the one from which the wedge of bone can most easily be removed Distortion as a complicating factor is avoided by placing the thin wedge of bone directly on the film holder

To determine the size of an area of metastasis that could be visualized on the

ROENTGEN-RAY EVIDENCE OF METASTATIC MALIGNANCY IN BONE¹

By HENRY SNURE, M D , and GEORGE D MANER, M D , Los Angeles

SEVERAL years ago, following an autopsy on an extremely emaciated individual, we reviewed the roentgenograms of his lumbar spine, which had

out most of the vertebral bodies. Microscopic examination proved that tumor cells had replaced most of the marrow cells without destroying the trabeculae of the



Fig 1 Metastasis from primary carcinoma of the liver to the vertebrae ribs and ilia. Thin wedge of vertebra 0.5 centimeter in thickness removed by hammer and knife method is pictured in central portion of film. Vertebra marked *A* has as large a metastatic nodule as vertebra marked *B* but without roentgen ray evidence of same. Compare density of cortical shadows with density of spongy portion

indicated changes in the fifth lumbar body alone. Autopsy showed macroscopic evidence of metastatic malignancy through-

spongiosa, however, there were several areas about one centimeter in diameter where the trabeculae were destroyed that could not be demonstrated on the film, and for this reason the present study was undertaken. Following this observation

¹ Presented before the Radiological Society of North America at the Twenty-second Annual Meeting at Cincinnati, Nov 30-Dec 4, 1936

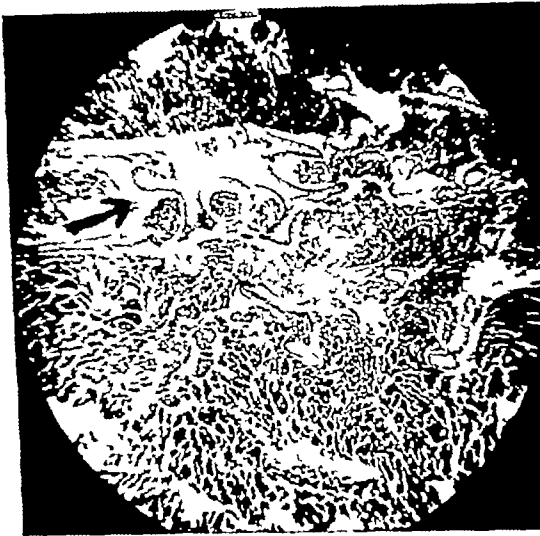


Fig 6



Fig 7

Fig 6 Photomicrograph of replacement type of metastasis to vertebral body, primary tumor is carcinoma of the stomach. Arrow points to minor trabeculae that are unchanged. Normal marrow above trabeculae with masses of tumor cells below; there is a tendency to gland formation in some areas.

Fig 7 Photomicrograph of metastasis to vertebral body—primary carcinoma of the breast. Tumor cells are scattered throughout marrow tissue. Trabeculae much enlarged, note osteoblasts along borders of the trabeculae as indicated by arrows. This is the osteoplastic type of metastasis which usually does give roentgen ray evidence of its presence.

no paraffin was used and it was not necessary that the halves of the ribs fit accurately upon each other.

A demineralization of all vertebrae, ribs, and pelvic bones was the only roentgenographic evidence of metastasis in two cases of myeloma in which we had made roentgenograms. Fraenkel also reports two similar cases of myeloma, but in each instance he had lateral views of the chest which showed an S-shaped deformity of the sternum. He says this does not occur in other types of metastasis. Simpson (2) reports a case of prostatic metastasis to nearly all the vertebrae, with only microscopic evidence of its presence. No change could be detected macroscopically when the vertebrae were sawed in two. This type of metastasis might be referred to as the replacement type. It should be kept in mind that pains along the spine often referred down the legs may be the first signs of metastatic malignancy. A negative roentgenogram at this time should be disregarded, particularly if a primary malignancy is known to exist elsewhere in the body. Chemical tests for blood serum, calcium, inorganic phosphorus and phos-

phatase activity, as suggested by Gutman (3) *et al*, are indicated as additional aids in the diagnosis of bone disease.

In studying the density of the epiphyseal plates, attempts were made to produce evidence of ruptured nucleus pulposus. With half of the fibrous intervertebral disc cut off the upper surface of a vertebra, circular and irregular shaped areas about one and one-half centimeters in diameter were depressed by tapping on small wooden or steel bars, variations of the spongiosa were barely visible on the film. A rubber-tipped metal cylinder one and one-half centimeters in diameter was driven through half of the fibrous disc, the epiphyseal plate, and into the body of the vertebra to various depths. When the holes were filled with paraffin, changes in the spongiosa were almost impossible to detect. The dense crescentic shadow usually found on films that visualize ruptured nucleus pulposus is probably due to a slow rebuilding of new bone at the rupture site rather than a piling up of the small fragments of the trabeculae of the spongiosa displaced by the cartilage. It seems reasonable to assume that in a recent rupture of the nucleus



Fig 4

Fig 4 Photomicrograph of vertebral body showing a few isolated nests of tumor cells indicated by arrows X are small trabeculae There is no roentgen ray or macroscopic evidence of metastasis Primary tumor was carcinoma of the breast



Fig 5

Fig 5 Photomicrograph of metastasis to vertebral body Primary tumor of the urinary bladder Arrow indicates trabeculae unaltered, with normal marrow tissue above and masses of tumor cells below the same Roentgen ray evidence of this replacement type of metastasis cannot be demonstrated on the film

roentgen film, we began by removing portions of the spongiosa of the vertebral bodies and filling the cavity with muscle scraps, water, or paraffin. Spongiosa occupying an area of $2 \times 2.5 \times 2.75$ cm and 1 cm deep can be removed from a vertebral body, and roentgenograms, made after filling this space with paraffin, give practically no evidence of change in the spongiosa. It would be impossible to visualize on the roentgenogram an osteolytic tumor of the above size in the vertebrae of a living person in which fine detail of the spongiosa would be partially obliterated by the film-vertebral distance and by superimposed soft tissue shadows. Apparently the cortical bone accounts for most of the *detail* of the osseous structures depicted on the film, while the spongiosa accounts for the general density. When areas of cortical bone one centimeter square are removed from the lateral surface of the vertebral body and the excavated area filled with paraffin, their location can be seen on the roentgenograms. Holes, made by a trephine one centimeter in diameter and extending almost across

the vertebral body after filling with paraffin, are not visible unless the central ray passes through the long axis of the hole and are not visible then if the cortex is replaced. In the anteroposterior view, on the film, you will find the superimposed parts of the posterior arch practically obscuring all evidence of holes when filled with air only. However, when filled with paraffin such holes are not visible on the film.

Similar findings can be demonstrated in other bones of the body. Films made of the tibia, with spongiosa of the marrow cavity (two centimeters in diameter) removed and filled with paraffin, show no change when compared to films of tibia before removing spongiosa, the soft tissues (such as muscle) remaining in place in both instances. Likewise, an os calcis can be sawed lengthwise into halves, spongiosa curetted out, and a space from one and one-half to two centimeters in diameter filled with paraffin, there resulting no evidence of change on the subsequent film. Ribs sawed lengthwise and marrow curetted out show no deviation on the film from the normal. In the case of the ribs

ing a wedge of bone from the vertebræ is suggested, recognizing of course, that complete removal of the spine and several sections of same is a superior method

(3) By sectioning all bones at autopsy, Kaufmann (9) found 72 per cent of bone metastasis in prostatic carcinoma Bumpus (10), by using the roentgenogram alone, found 30 per cent of prostatic metastasis

(4) It is reasonable to suppose that destructive changes in the marrow space due to infection may likewise not be visible on the film

(5) Distortion of detail on the roentgenogram is avoided by using a thin wedge of bone, this also requires less laboratory space

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Fig 8 Upper figure shows an air filled nucleus pulposus rupture produced by rubber-tipped rod Lower figure shows same with space filled with paraffin no roentgen ray evidence of same, indicating that recent ruptures of the nucleus pulposus give no roentgen signs

pulposus no x-ray evidence of rupture can be demonstrated on the film

The excellent experiments of Lachmann and Whelan (4) show that only under very favorable circumstances can a decalcification under 20 per cent be diagnosed, and in most bones a loss of from 20 to 40 per cent of calcium is necessary. In their experiment to determine the relative part played by the cortex and spongy layer in producing the roentgenogram, they found that in the vertebrae and os calcis the spongy portion was the most important for the production of density. In other bones the two bony structures shared about equally in the production of shadows. Variations were also found in different parts of the same bone.

It should be remembered that their experiments were made on the isolated bone and compared to a film of its normal appearance with no soft tissue shadows intervening. They also point out that decalcification by a biologic process may be different than that produced by chemicals. Slight motion of the living patient during the exposure of films must also be considered as a confusing factor.

No extensive comparison was made to determine relation between type of primary tumor and type of metastasis, but our observations lead us to believe that the theories given by Hastings and Downs (5) are correct. The tumors with considerable fibroblastic change usually give rise to the osteoplastic type of metastasis, and are, therefore, visible on the roentgenogram. Shields and Whitham (6) state that insofar as grading of tumors is concerned there is little evidence of correlation between the histologic appearance and extent of metastasis in the individual case, except that tumors, with many abnormal mitotic figures usually kill promptly and have widespread metastasis. Unfortunately, the metastasis may be the first sign of the disease, and may be preceded by a period of pain along the spine and referred down the legs with no roentgenographic evidence of the metastasis present.

After nearly completing our experiments we found that somewhat similar work had been done in 1928 by Chasin (7) in the study of two cases of proved tuberculosis of the spine. He reported one patient, 28 years of age, who did not give roentgenographic evidence of disease until one year after the onset, another patient, six years of age, presented roentgenographic evidence three months after clinical signs of tuberculosis were first noted. Later we also found the article by Böhmig and Prevot (8) regarding the experimental production of ruptured nucleus pulposus. Our results in depicting on the film the artificially produced rupture of the nucleus pulposus did not agree with Prevot's findings. In 37 per cent of Prevot's proved autopsy cases no roentgenographic signs of ruptured nucleus pulposus were demonstrated. However, most of these were rather small in size.

GENERAL COMMENTS

(1) Widespread metastasis of malignant tumors to the osseous structures without demonstrable evidence in the roentgenograms is not an infrequent occurrence.

(2) A rapid and easy method of remov-

administration of thorium-X upon a large series of mice, rats, rabbits, and dogs. They found the comparable lethal doses, expressed as radium equivalents, to be much smaller than those which Proescher and Almquist (6) reported using radium chloride. Stevens (11) treated six patients having different types of lymphomas, with x-ray and injections of radium. Each patient received from 150 μgm to 250 μgm of radium chloride by vein. Improvement was noted in four of the six patients, but, since x-ray therapy was given to all but one, no definite clinical evaluation of the effect of the radium could be made.

Seil, Viol, and Gordon (12) measured quantitatively the excretion of radium following the intravenous administration of 100 μgm of radium chloride to a 23-year-old male. They found that over 40 per cent of the amount given was excreted in the feces, and only 2 per cent was eliminated by the kidneys. On the ninth day after the injection, no radium could be detected in the urine, and less than 0.5 per cent was excreted in the feces. Two months later the experiment was repeated upon the same subject and similar values were obtained. Seil, on two different occasions, took 50 μgm of radium chloride by mouth, similar activity-studies were made and it was observed that within four days approximately 60 per cent was lost in the feces, but less than 0.15 per cent was eliminated in the urine during the first two days following the ingestion of the radium. During the last experiment it was found that, ten hours after the radium was taken, 588 μgm per liter was present in the expired air from the lungs, but at the end of 38 hours this amount had fallen to 70 μgm per liter. The authors came to the conclusion that soluble radium salts are eliminated principally by way of the intestinal tract, and that within a few days the radium becomes firmly fixed in the body tissues.

Barker and Schlundt (13) examined 10 patients who had received from 80 μgm to 1,455 μgm of radium chloride, and observed that relatively small amounts

were retained. Schlundt, Nerancy, and Morris (14) measured the activity of a group of 12 inmates of the Elgin State Hospital who, altogether, had received a total of 2,190 μgm of radium. At the end of six months, only 4.3 per cent was retained by these patients, and six months later only 1.9 per cent remained of the amount originally given. Schlundt and Failla (15) determined the rate of excretion of two women who had become radio-active twelve years previously. The activity of the first patient was found to be 24 μgm , and that of the second was 14 μgm . The coefficients of excretion per day were 0.005 per cent and 0.0026 per cent, respectively, and it was noted that over 85 per cent of the radium eliminated was present in the feces. They repeated the experiment of Seil, Viol, and Gordon (12) by taking from 2 μgm to 5 μgm of radium bromide by mouth, but observed that from 91 to 98 per cent was eliminated within from four to five days.

In 1925, Martland, Conlon, and Knief (16) described a group of cases of occupational poisoning in girls employed as dial painters in a watch factory. Later Martland (17) published a more detailed report concerning these unfortunate women. He discussed the relation between the cause of death and activity of the body at the time of death. The earlier deaths resulted from a profound anemia which was frequently complicated by necrosis of the jaw, and the activity of these patients was found to be as great as 180 μgm . The majority of the patients succumbing at a later date died from a rapidly growing type of osteogenic sarcoma. The members of the latter group were, on the whole, less radio-active, and one patient had only 10 μgm contained within her body at the time of death. Several of the patients had developed bone changes suggestive of early sarcoma at the time the article was written. Flinn (18) examined a number of similar patients, and noted the same relation between the degree of activity of the patients and the cause of death. He described several living patients suffering from re-

THE INTRAVENOUS AND INTRADUODENAL ADMINISTRATION OF RADIO-SODIUM¹

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THE internal use of the radio-active elements was reported by many investigators in this country and abroad within a few years after these substances became available for medical purposes

In 1914, Proescher (1) gave from 50 μ gm to 350 μ gm of radium chloride² by vein to more than a score of patients and stated that there were no immediate toxic manifestations to be noted. He stated that marked symptomatic and clinical improvement was observed in patients with arthritis and hypertension. Similar studies were made and conclusions reached by Field (2), Delano (3), Moriarta (4) and Pinch (5). However, these investigators did not make control studies, and their follow-up reports were inadequate.

Proescher and Almquist (6) reported the effect of radium given parenterally to a small series of rats and mice. They attempted to evaluate the relation between the amount given and the length of life after injection. They followed the blood counts of all the animals and noted the pathologic changes at the time of death. Death occurred in both rats and mice from 30 to 45 days after the administration of 900 μ gm to 1,300 μ gm of radium chloride per kg of body weight.

Several mice received from 2,000 μ gm to 4,000 μ gm per kg and died within a period of from seven to ten days. In these animals they found a transient rise of the erythrocyte and leukocyte counts, and a rapid and profound leukopenia with complete destruction of the polymorpho-

nuclear forms. Central necrosis of the liver was noted in almost all of the animals. The lymph nodes and spleen showed degenerative changes with marked destruction of lymphocytes and numerous small areas of necrosis. In the bone marrow similar changes were seen, accompanied by decrease of myeloid cells and rupture of the capillary walls.

Cameron (7) examined the organs of a woman who had received 1,000 μ gm of radium chloride by vein three and a half months prior to her death from a carcinoma of the uterus. He found from 0.006 μ gm to 0.0048 μ gm per gm (dry weight) in the bone marrow, 0.0061 μ gm per gm in the liver and smaller amounts in the other tissues. There were apparently no activity-measurements made of the bones.

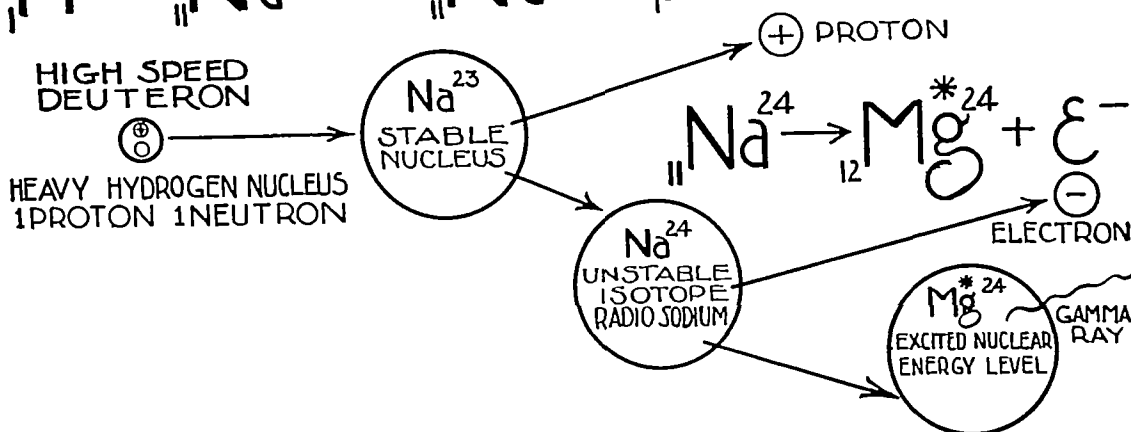
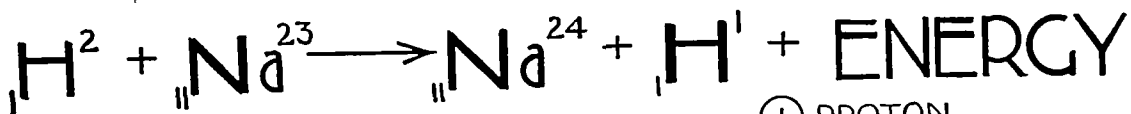
Proescher and Almquist (8) described two patients who received large doses of radium over a period of many months. The first, a case of pernicious anemia, was given a total of 900 μ mg in nine months, and underwent a definite clinical remission which persisted up to the conclusion of the treatment. No subsequent report was made of the final outcome or of the patient's course after the therapy was discontinued. The second patient, a case of myelogenous leukemia, received 2,700 μ mg over a period of 17 months without any significant change in the erythrocyte or leukocyte counts. Arneth (9) treated a patient with pernicious anemia with a stated total of 380 E S U of thorium-X over a period of four months, and at the end of that time noted a marked remission associated with an increase of the leukocyte counts. Hirschfeld and Meidner (10) conducted an extensive study of the effect of the intravenous

¹ Presented before the Radiological Society of North America at the Twenty second Annual Meeting at Cincinnati Nov 30-Dec 4 1936

² All quantities given are expressed in terms of radium element

RADIO SODIUM

PRODUCED BY DEUTERON BOMBARDMENT



β -PARTICLES EMITTED WITH AN AVERAGE ENERGY OF APPROXIMATELY .5MV
 γ -RAY EMITTED WITH ENERGY OF 1MV, 2MV, 3MV, IN THE RATIO OF 3:3:2

Fig 1

is limited by the short half-life of only 14.8 hours. The patients whose protocols are given below were selected because they were the only individuals with leukemia available at such times as the radio-sodium could be obtained.

PREPARATION AND ADMINISTRATION OF RADIO-SODIUM

The samples given to the first patient were prepared each time by the deuteron bombardment of from 3 to 4 gm of sodium chloride. The activated salt was brought quickly to the hospital, and dissolved in sufficient water to make an approximately isotonic solution which was filtered and boiled. The activity was measured with a small quartz fiber electroscope, and the solution immediately administered by vein to the patient.

The radio-sodium for the second patient was obtained each time by the deuteron bombardment of approximately 1 gm of

metallic sodium. This was dissolved in dilute hydrochloric acid of such a concentration (147N) that when the solution became neutral to litmus, it was isotonic. The first dose was given by vein, but the second was introduced intraduodenally. This latter procedure was accomplished by passing a small Rehfuß tube under the fluoroscope so as to insure that the tip was well within the duodenum.

TECHNIC OF ACTIVITY MEASUREMENTS

A large Curie type of electroscope was used for the activity determinations of the last two samples, as well as for all the measurements of the radio-activity of the two patients and their body fluids. The instrument was calibrated against a 10.12 mg sample of radium which had been previously checked by the United States Bureau of Standards. The radium standard was placed at distances of 160, 40, 20, and 15 cm from the center of the chamber

peated pathologic fractures of the long bones and loosening of the teeth in whom the activity was as low as 2 μgm

Gettler (19) reported the case of a man who consumed a total of 1,400 bottles of radium chloride, each containing 2 μgm , over a period of five years. The patient entered the hospital in a state of marked anemia and emaciation, which was complicated by an extensive necrosis of the jaw. Postmortem studies showed hyperplastic changes in the bone marrow. The activity of the entire body was found to be 73.6 μgm , with all but 0.5 per cent contained in the bones.

The inconclusive clinical results of the earlier work concerned with the internal use of radium, together with later reports of radium poisoning, have apparently served to discourage further investigation in this direction. The amount which would be sufficient to be clinically effective probably would be fatal within a few years, due to the tendency of the radio-active elements to be deposited in the bones.

In 1934, Curie and Joliot (20) announced that they had prepared a radio-active isotope of nitrogen by the bombardment of boron with the alpha particles of polonium. They were able to prove the chemical identity of the radionitrogen, and shortly afterwards radiosilicon and radiophosphorus were similarly obtained from magnesium and aluminum.

Lawrence and Livingston (21) designed and constructed a magnetic resonance accelerator with which they studied the effect of bombardment of numerous substances, using at first protons and alpha particles, and later deuterons. Soon after the discovery of radio-activity was announced, Henderson, Livingston, and Lawrence (22) reported that they had induced artificial radio-activity in the elements of the first two rows of the periodic table, using the cyclotron.³ Later, Lawrence and Livingston (23) were able to stimulate radio-activity in elements as heavy as platinum. During the earlier phases of

this work, the deuteron beam of the cyclotron carried an energy of a few microamperes at a potential of approximately 2 million volts (MV). However, at the time of writing this paper, Lawrence (24) informs us that he and his co-workers have recently obtained an intense deuteron beam of over 100 microamperes at 6 million volts (MV). With such an energetic beam it is possible to obtain as much as 1 gm radium equivalent of radio-sodium.

In Figure 1 is shown schematically the nuclear reaction by which radio-sodium is formed. The rapidly moving deuteron, upon approaching the sodium nucleus (Na^{23}), becomes distorted in such a manner that the neutron is separated from the proton, the neutron entering the nucleus while the proton is repelled from the intensely positive field. When the Na^{23} acquires the neutron from the deuteron, it becomes heavier by the weight of the neutron and becomes Na^{24} . This isotope of sodium does not occur in Nature and is energetically unstable, and in the course of 14.8 hours, on the average, emits a high-speed electron from its nucleus. When this electron is discharged, Mg^{24} is formed, and the magnesium nucleus is left with an excess energy which is immediately radiated as a gamma ray.

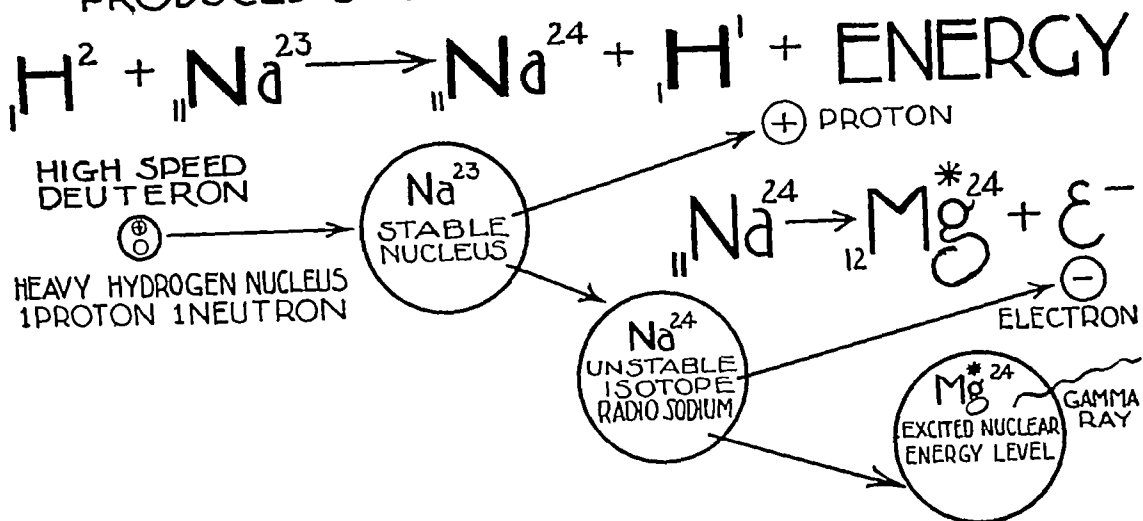
The electrons (*i.e.*, beta rays) are emitted over a relatively broad spectrum, and, according to Kurie, Richardson, and Paxton (25), with an average energy of approximately 500 kv. Richardson and Kurie (26) state that the gamma-ray spectrum is composed of radiations carrying the energies of 1 MV, 2 MV, and 3 MV, with a ratio of intensity equivalent to 3:3:2.

In the Spring of 1936 the Radiation Laboratory of the University of California was able to furnish radio-sodium upon several occasions in amounts sufficient for clinical investigation. It was felt that many of the disadvantages of internal radium therapy could be avoided by the use of radio-sodium, inasmuch as this latter substance does not become fixed in the body tissues and the duration of its effect

³ For the sake of brevity the magnetic resonance accelerator is commonly spoken of as the cyclotron.

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of the electroscope The varying rates of fall of the leaf over each portion of the scale were observed, so that the rate of discharge at any point upon the scale was known for each distance The background was determined daily during the time that the instrument was being used, and the necessary corrections made The units of measurement of activity are expressed as either millicurie equivalents (mce) or microcurie equivalents (μ ce)

The activity of each patient was determined by placing the electroscope at a distance of 160 cm from the tip of the xyphoid process of the patient's sternum The subject was always in the recumbent position with the knees drawn up and the arms folded across the chest The difference observed in each experiment between the activity of the sample administered to the patient and the measured activity of his body immediately after injection, is considered to be due to the absorption of the gamma radiation by his tissues The activities of the body fluids and feces were measured with the electroscope at a distance of either 20 or 40 cm, depending upon the strength of the sample Several specimens were so feebly radio-active that determinations had to be made at a distance of 15 centimeters Whenever possible, measurements of a given sample were made at two different distances The activity of the sweat was obtained by measuring the activity of the bed-linen, night-clothes, towels, and the mattress, after the patient had been sponged and removed to another part of the building The relative activities of the blood plasma and the corpuscles were obtained by centrifuging 50 cc of oxalated blood, washing the cells once with 50 cc of normal salt solution, and measuring the activity of the cells and then that of the plasma combined with the wash-fluid

All the values given for the body-fluids were corrected for the amount of radio-sodium lost by decay during the interval of time between the collection and measurement of the samples

REPORT OF CASES

Case 1 G M, a white male, aged 29 years, entered the University Hospital in March, 1936 He had first noticed generalized adenopathy in February, 1935, and in July of the same year began to experience increased fatigability, dyspnea upon exertion, and progressive enlargement of the abdomen He was seen in the Out-patient Department in September, 1935, and transferred to the hospital where, after routine blood studies and a biopsy of a cervical lymph node, a diagnosis of chronic lymphatic leukemia of the aleukemic type was made He received an intensive course of deep x-ray therapy and, after considerable improvement, was discharged Before his second entry into the hospital there had been a recurrence of the symptoms mentioned above, accompanied by marked loss of weight Physical examination when he re-entered showed him to be a male 55 kg in weight, chronically ill, with a moderate degree of generalized lymphadenopathy, marked hepatomegaly, and a blood-cell count of 3,600 leukocytes per c mm, with 80 per cent lymphocytes, 45 per cent hemoglobin, and 2,170,000 erythrocytes After consultation, it was decided to make this patient the recipient of the first intravenous administration of radio-sodium On March 23, 1936, he was given 11 mce of radio-sodium by vein, and four days later he received 13 mce more in the same manner During the two-weeks period following the administration of the radio-sodium, no significant alteration of the blood picture or clinical condition was observed At no time was there any reaction noted which might have suggested a toxic reaction to this substance It was felt then that adequate time had been allowed for the experiment and that the patient should be given a course of deep x-ray therapy Following the x-ray treatment he improved slightly and was discharged

Case 2 O R, a white male, aged 23 years, entered the University Hospital for the first time in September, 1936, with a

diagnosis of chronic myelogenous leukemia. He stated that for four years he had observed a slow but progressive enlargement

25, 1936. During the period of administration of the radio-sodium and throughout the following week there was no signifi-

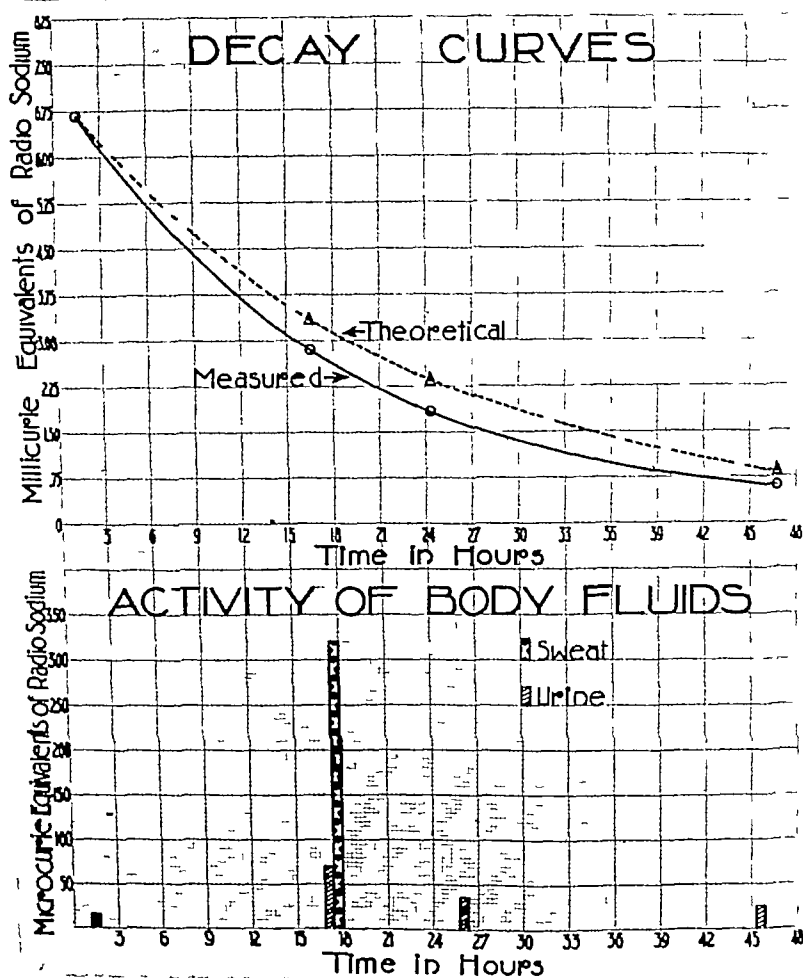


Fig 2

of his abdomen, three months before entry his condition became much worse, with malaise, rapid enlargement of his abdomen, diarrhea, nausea and vomiting, and repeated bouts of fever. Physical examination showed a young man 65 kg in weight, chronically ill, with a markedly distended abdomen which was almost entirely occupied by the spleen. The leukocyte count was 700,000 per c mm, with 40 per cent neutrophilic myelocytes, the hemoglobin was 56 per cent, and the erythrocytes 3,100,000. He received 15 mce of radio-sodium by vein on Sept 20, 1936, and 39 mce intraduodenally on Sept

25, 1936. During the period of administration of the radio-sodium and throughout the following week there was no significant change in the blood picture, and the patient's general course continued to be unfavorable. He was then given deep x-ray therapy to the spleen, which was followed by an excellent clinical response, and he was discharged two weeks later. The same lack of definite clinical response and absence of toxic effect were observed with this patient as were noted in the first case.

RESULTS

The lower curve (solid line) of the upper section of each chart (Figs 2, 3, and 4) represents the actual measurement of the

patient's radio-activity following the injection of radio-sodium. The upper curve (dotted line) indicates the theoretical rate of decay of the radio-sodium. The lower

decay during the one and a half hour interval, is considerably greater than is to be observed in Figures 3 and 4. This apparent discrepancy is probably due to

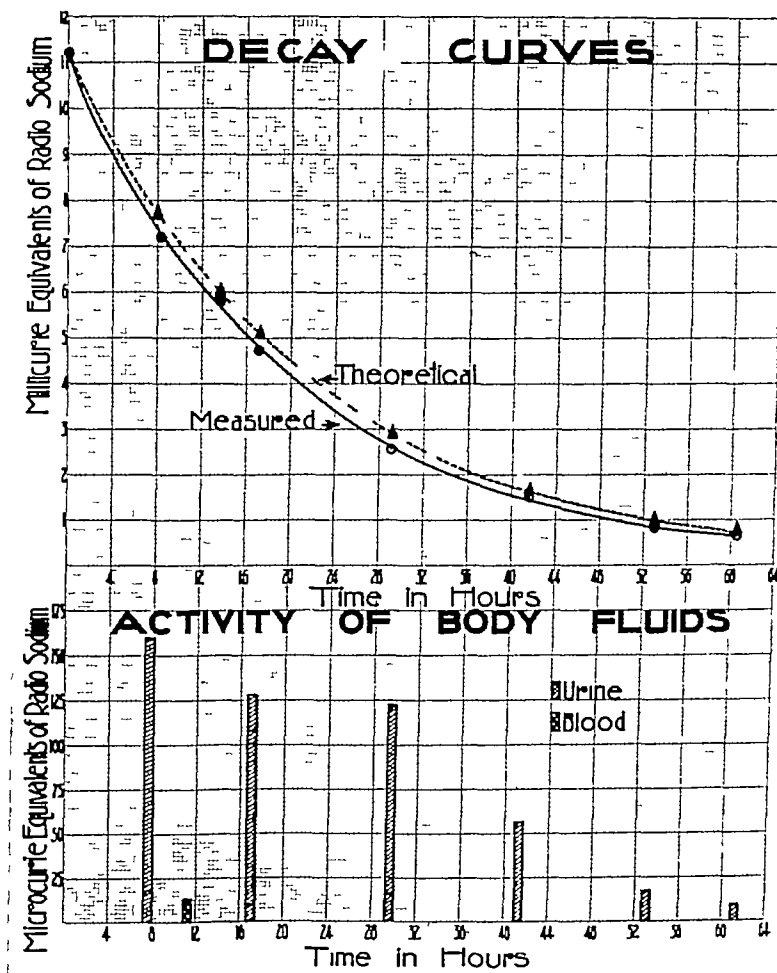


Fig 3

portion of each chart illustrates the amount of activity observed in the various body fluids. The abscissa represents the intervals of time following injection, and the ordinate the degree of radio-activity.

The values in Figure 2 were obtained following the administration of 13 mce of radio-sodium to the first patient (G. M.). The initial measurement of the activity of his body was not made until one and a half hours after injection. The difference between the amount given and the first activity determination, allowing for

the fact that in this instance the radio-sodium, prior to administration, was measured with another type of electroscope which was not available for accurate calibration.

The interval between the actual and the theoretical decay curves in Figure 2 is felt to represent the quantity of radio-sodium lost through the various channels of elimination. This view is borne out by the fact that the quantity excreted by the subject corresponds approximately to the difference between the two curves. The

large proportion of radio-sodium lost in the sweat can be explained by the fact that the patient had frequent and drenching sweats during his stay in the hospital

In the third and final experiment, the second patient received 39 mce by duodenal tube. A distortion of the first portion of the measured decay curve ap-

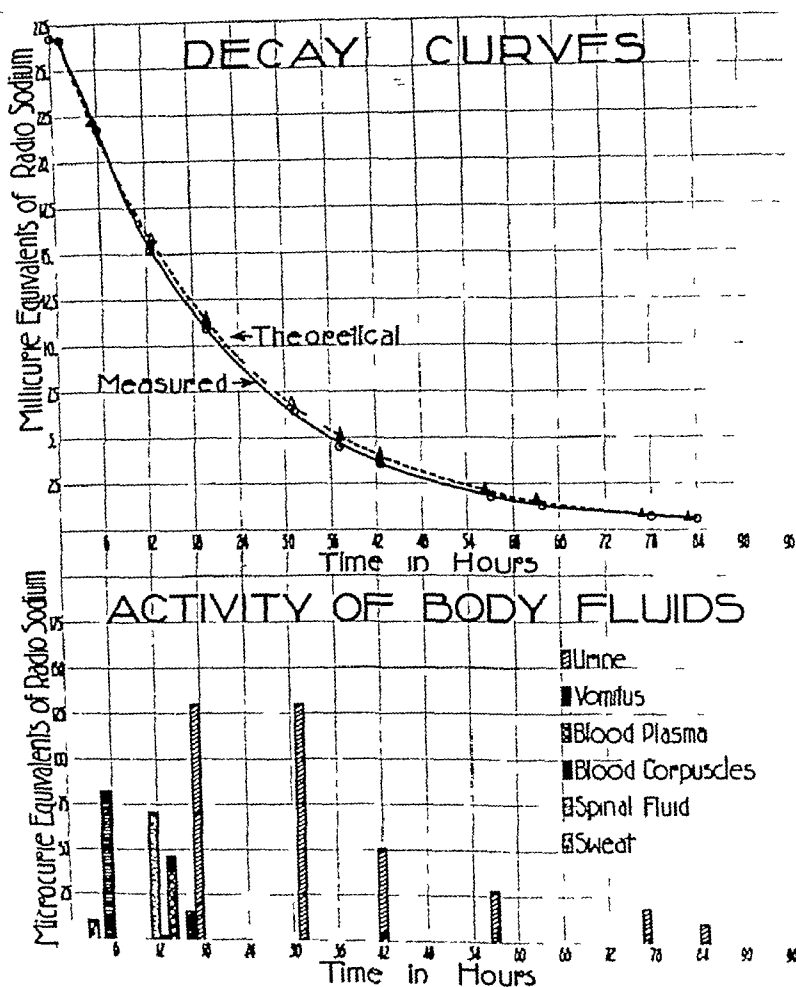


Fig 4

Following the administration of 15 mce of radio-sodium to the second patient, it was observed (Fig 3) that the amount lost in the urine was relatively greater than in the previous case, but no activity could be detected in the sweat, and the proportionate total loss was less. This result might be interpreted as being due to two factors first, this subject received less sodium chloride, and second, he did not perspire as much. In addition, 100 cc of blood was withdrawn and its activity determined

pears in Figure 4. In this instance, the radio-sodium at the completion of administration was concentrated in the duodenum and jejunum with the enormous spleen between the salt and the electroscope. Since it was felt that the absorption and distribution of the radio-sodium by the blood should have been complete within an hour, the theoretical decay curve was started at the second point of the measured decay curve. However, it is noted that the theoretical curve falls just below the actual curve and does not cross above the

patient's radio-activity following the injection of radio-sodium. The upper curve (dotted line) indicates the theoretical rate of decay of the radio-sodium. The lower

decay during the one and a half hour interval, is considerably greater than is to be observed in Figures 3 and 4. This apparent discrepancy is probably due to

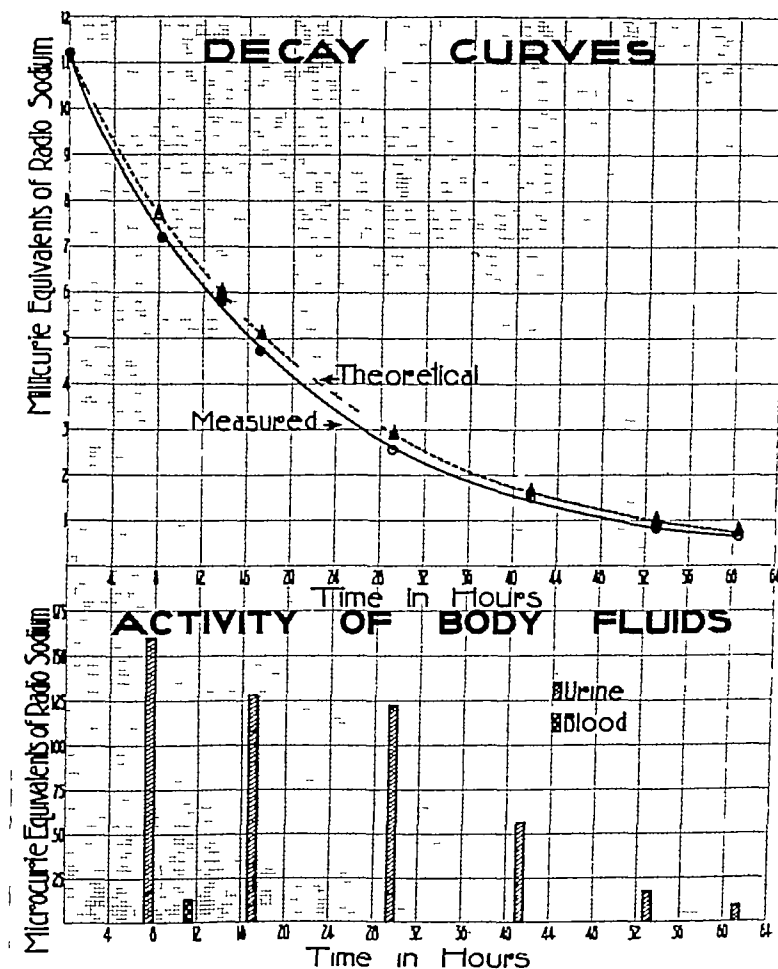


Fig 3

portion of each chart illustrates the amount of activity observed in the various body fluids. The abscissa represents the intervals of time following injection, and the ordinate the degree of radio-activity.

The values in Figure 2 were obtained following the administration of 13 mce of radio-sodium to the first patient (G. M.). The initial measurement of the activity of his body was not made until one and a half hours after injection. The difference between the amount given and the first activity determination, allowing for

the fact that in this instance the radio-sodium, prior to administration, was measured with another type of electroscope which was not available for accurate calibration.

The interval between the actual and the theoretical decay curves in Figure 2 is felt to represent the quantity of radio-sodium lost through the various channels of elimination. This view is borne out by the fact that the quantity excreted by the subject corresponds approximately to the difference between the two curves. The

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DISCUSSION

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which mean gamma-ray measurements Now radio-sodium gives only hard gamma and beta, but radium (including its products) gives also alpha ray in tenfold total energy! So for intravenous therapy we ought to say that for *initial activity* one milligram of radium equals ten millicurie equivalents of radio-sodium

But the absence of alpha radiation is precisely the thing that interests me most in radio-sodium It means that the tissue ionization is similar by intravenous usage to what it is by external irradiation Whereas for radium intravenously, the picture is dominated by the alpha rays with ionization one hundred times as dense along their tracks I mean, there is physical basis for expecting a qualitatively different biologic action (Professor Lawrence's paper, read later, on neutron rays has concern with this same difference)¹ Clinical experiments with radio-sodium by vein ought to be carried further

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They all knew, and we knew, that giving x-ray treatments to these patients would improve their condition Therefore, the experiments were continued only as long as we dared let the patients go and then x-ray therapy was given The experiments terminated of necessity at that time

We say there were no clinically observable effects We know there were no clinically observable effects within the period of about two weeks of observation We justify that short period of observation because, with x-ray therapy, you usually see observable clinical effects much before two weeks on patients of this type However, we were particularly interested in

¹ Added by Dr Newell later

latter until more than six hours have elapsed, this observation suggests that absorption was not completed until more than six hours after administration of the radio-sodium. After equilibrium has been apparently established, it is to be noted that the gap between the two curves is relatively less than in the previous charts. Since the half-life of the radio-sodium is relatively short, the amount left within the body rapidly decreases. Similarly, the quantity eliminated over a given period becomes less as the interval of time increases from the moment of administration. Because of these two factors, the measured and theoretical decay curves approach each other toward the end of the period of measurable activity in all three experiments.

During this last investigation, the patient vomited twice, but no marked loss occurred from this source. Twelve c c of spinal fluid and 50 c c of blood were withdrawn, and their activities are expressed as μc e per 100 c c for the sake of comparison. The column for the blood is divided so as to represent the corpuscular and plasma activities. The value obtained for the sweat was only 1.2 μc e and cannot be clearly seen on the chart. The first urine sample was lost and is indicated as a question mark ("?"). In all three series of determinations, the activities of the feces were too feeble to be measured.

CONCLUSIONS AND SUMMARY

1. Radio-sodium can be given internally to human subjects without toxic effect, in amounts up to 53 m c e.

2. The rate of decay within the body, the proportion eliminated, and the concentration of radio-sodium in the body fluids can be directly measured.

3. The quantity of radio-sodium given did not produce observable clinical effects. Further investigations with the use of larger amounts in other patients are essential before any estimation of its therapeutic value can be made.

4. Less than 10 per cent of the total amount of radio-sodium given was ob-

served to have been eliminated by the body within the period of its measurable activity.

5. A new method has been developed for studying the metabolism of sodium within the body. A similar line of investigation can be followed, using other artificially prepared radio-active elements.

We are deeply indebted to Prof. Lawrence and his co-workers in the Radiation Laboratory of the University of California for their co-operation in preparing the radio-sodium and their advice concerning physical measurements, also, through them are we grateful for the support of the Research Corporation, the Chemical Foundation, and the Josiah Macy, Jr., Foundation, whose contributions made possible the supply of radio-sodium. We have been encouraged and advised by members of the Medical Department, and especially by Dr. S. R. Mettler and Dr. E. H. Falconer, to whom we express appreciation.

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seeing what the reaction of these patients would be and the paper as published shows that the doses we gave were gradually increased. We intend to step the doses up to much larger amounts to see what will happen.

After all, we are only putting sodium chloride into the patients and there can be no toxicity, but that had to be proved before we could go to tremendous doses.

Dr. Newell mentioned the fact that there are no alpha radiations from radio-sodium. This may account for the lack of response to large doses—when patients respond to such small doses of radium chloride. One of the interesting features of artificially activated elements is that each has a slightly different type of radio-activity. This fact may be of therapeutic value in the future.

NOTE OF A NEW AND APPARENTLY USEFUL BIOLOGICAL INDICATOR OF X-RAY DOSAGE

By C P HASKINS, PH D, *Schenectady, N Y*, and E V ENZMANN, PH D, *Cambridge, Mass*

From the Haskins Laboratory, Schenectady, N Y, and Biological Laboratories, Harvard University, Cambridge, Mass

IT HAS long been recognized that fundamental investigations of the physiological effects of electromagnetic radiations of high quantum energy are very largely dependent, on the biological side, upon the availability of suitable test objects. Such test objects should be small in volume but of such size as to be readily visible to the naked eye so as to minimize the technical difficulties involved in the examination of large numbers, should be available in such quantities as to be adaptable to long-range statistical investigations involving large populations, should be genetically and physiologically standardized to as great an extent as possible, and should, above all, present sharp and unmistakable end-points as criteria of effect.

A very considerable range of material has been explored in the past in an extensive effort to locate and standardize such a tool. Probably nothing has been found more generally adaptable and suitable for fundamental investigations in the biological effects of x-rays and cathode rays than the ova of the fruit fly, *Drosophila melanogaster*. The technic of rearing and handling the flies, isolating, raying, and observing the eggs has been extensively described by Packard (1), P S and C T Henshaw (2), Glocker and his collaborators (3), and others, and is well known. So far as is known to the authors, failure of the larva to emerge from the egg, or abnormalities of embryonic development have been the criteria of effectiveness used, and wild-type stock has been employed in every case.

For several years the writers have been engaged in a reasonably extensive statistical study of the incidence of mosaic colorless patches in the ommatidia of the com-

pound eyes of adults of eosin *Drasophila melanogaster* x-rayed as eggs or very young larvæ, continuing an investigation initiated by Patterson (4), in 1929. A study was originally undertaken of the frequency distribution of mosaics of white eye color, resulting from somatically affected cells of the eye anlage, in an x-rayed population as a function of the incident energy input. The original purpose of the work was to so treat the data as to give information, first, of the number of ion passages required to traverse a given genic locus to achieve the desired effect, and second, the magnitude of the volume or aggregate of volumes in a cell within which the "hit" must occur. After considerable acquaintance with the material, however, the authors have come to feel that it presents a sufficient number of unusually desirable characteristics as a biological indicator of x-ray dosage to be possibly worthy of wider application in therapeutic work. The effect sought presents a sharp, reliable, and readily observed end-point, its frequency of occurrence varying with x-ray dosage at a single series of wave lengths in so direct a fashion as to indicate that a rather simple effect may be involved. It has been reproducible by different workers to within less than the probable error of any determination, and the populations required are not excessive, although definitely greater than in the case of killing experiments. Finally, the information derived is capable of use in a number of auxiliary investigations of possible interest, as will be described. It is with the hope that it may be of some possible interest or help to others interested in the field that a description of the material and its application is given.

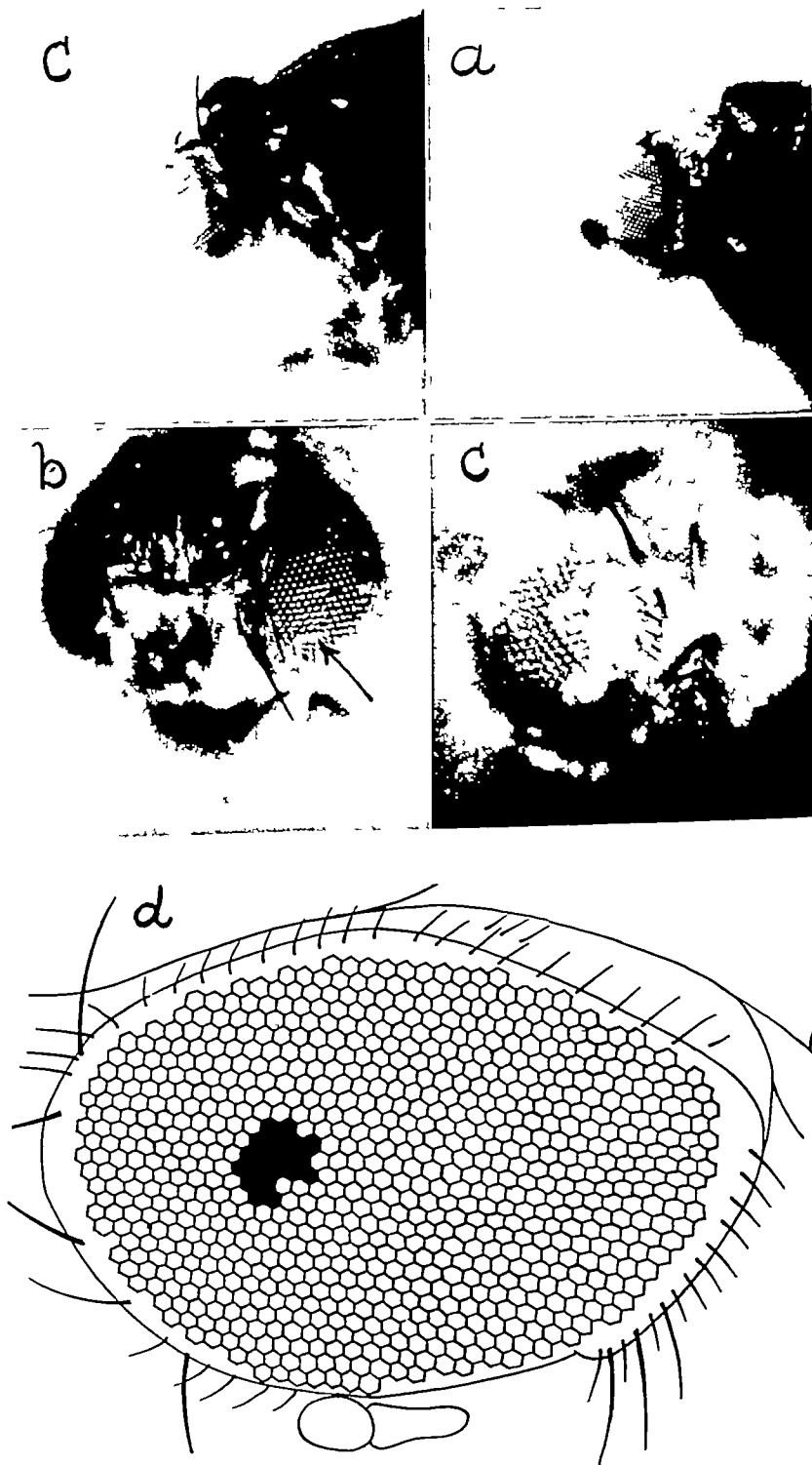


Fig 1 Types of mosaic patches in the compound eyes of X-rayed eosin *Drosophila* (a) Affected male showing white patch on light eosin background (b) Affected female showing light eosin patches on dark eosin background (c) Double white female showing white patch on dark eosin background (d) Diagrammatic representation of typical patch in upper lobe of compound eye

NATURE OF MATERIAL

Patterson has shown that x-rayed larvæ of *Drosophila* may at maturity bear mosaic patches of white eye color, composed of somatic tissue arising from single cells of the eye anlage affected at the time of irradiation. The anlage cell rather than the whole organism can thus be made the individual of experiment, and the number of mutations in irradiated material increased owing to the number of cells in the anlage at the time of treatment.

The stock of *Drosophila* selected for the present experiments was homozygous eosin. Two strains were used, one obtained from the Turtox Service Department, at Chicago, the other through the courtesy of Dr G. Pincus, of this laboratory. The factor is genetically bicoloric. Mosaics in the males take the form of white, irregular patches composed of a variable number of ommatidia, superposed on the light eosin, male-color background. In the females, the observed patches, of the same shape and size range as in males, are composed of light eosin or male-color ommatidia superposed on the dark eosin, female-color background. Very rarely does a white patch occur against the dark eosin background. We have indicated elsewhere (5) that the observed frequency of occurrence of this condition corresponds rather closely to the expected frequency on the assumption that in such cases the given cell nucleus was inactivated at both white loci by separate electron passages. The characteristic appearance of mosaic patches in the male, female, and "double-white" female is shown in the accompanying figures. It is of interest to notice that Patterson has presented good evidence to show that these changes are in eosin stock entirely due to so-called "single-locus" mutations, since chromosome aberrations in the female take the form of dark-eosin patches, which are indistinguishable against the already dark eosin background. In males, large chromosomal deletions result in the production of pits in the eye surface since they seem to be fatal both to the cell involved and to the ommatidia

which would have descended from it (Fig 1, *a*, *b*, *c*, and *d*)

EXPERIMENTAL PROCEDURE

Flies were reared in half-pint milk bottles containing cooked banana-agar or corn-meal-molasses-agar medium, and inoculated in some cases with the standard brands "G-M" culture of yeast, in others with cells from standard commercial Fleischmann cakes. Slanting milk bottle cultures have been used in these laboratories for some time, and have proved much superior to the usual ones. In the latter, excess carbon dioxide is often trapped below the agar block, forcing it upward and submerging and destroying pupæ and adults, and limiting the available space upon which larvæ may feed. "Gassing" has been eliminated in the slant cultures, and the oblique surface provides a much greater feeding area, permitting a larger yield of flies per bottle. To ensure the obtaining of many cultures of uniform slope, and to permit the handling of bottles in quantity, one of us (E. V. E.) has devised the rack here figured, the dimensions being so chosen that it will hold 25 half-pint milk bottles, and will fit into an autoclave of standard size. Racks of this type have proved of great convenience, the bottles being held at an angle of 45° and most effectively used with about 50 c.c. of medium (Fig 2).

It has been found of less importance in this work than in that of Packard and Henshaw that the ova used be of very nearly uniform age. However, an age spread from time of laying of more than six hours is not desirable. To prevent this situation, eggs were collected on drops of the agar medium mounted on glass plates, over which were inverted clean glass bottles containing a population of continuously laying adults. The plates were changed at intervals corresponding to the allowable age spread of the embryos. The use of young females from fresh cultures largely overcame the difficulties of egg retention, as indicated in Table 1-1, in

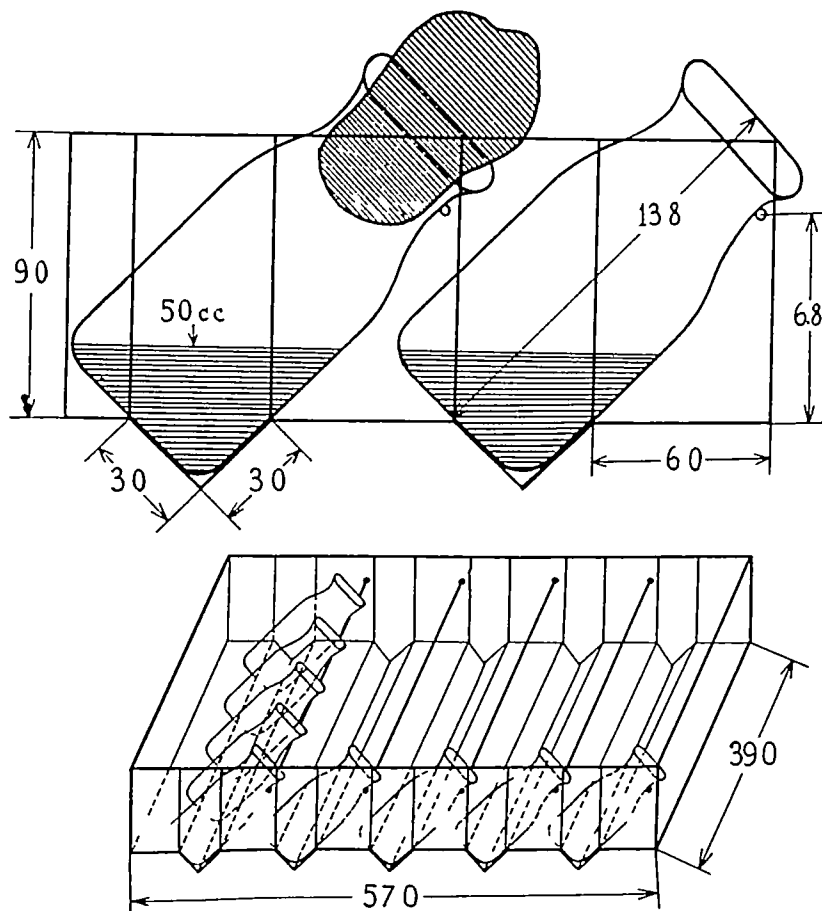


Fig 2 Slanting bottle rack used with good success in rapidly making large numbers of slant cultures

TABLE I—SHOWING THE NUMBER OF LARVÆ HATCHED AT THREE-HOUR INTERVALS FROM A GIVEN NUMBER OF EGGS

Time from End of Egg-laying (hr)	(a)		Time from End of Egg-laying (hr)	(b)		
	No Un-hatched Ova	No Larvæ		No Un-hatched Eggs	No Larvæ	
0	132	0	0	1 130	0	
3	125	7	3	1 124	6	
6	123	2	6	1 123	1	
9	121	2	9	1 123	0	
12	121	0	12	1 122	1	
15	118	3	15	1 109	13	
18	110	8	18	914	195	Total 1 062 larvæ
21	21	89	21	296	618	
24	7	14	24	105	191	
27	0	11*	27	73	32	
			30	61	12	
			33	61	0†	

* Error of counting = \pm larvæ

† Of the larvæ 61 failed to hatch the error in counting was seven eggs.

which are listed all larvæ hatching from a sample of 132 eggs laid at room temperature (22.5°C) during an interval of one hour. The females were taken from a culture seven days old. It will be seen that a certain number of retained eggs were deposited which hatched between three and nine hours after deposition. The maximum of presumably freshly fertilized eggs hatched at 21 hours after deposition, the total spread of this class being between 15 and 24 hours. In Table 1-B is shown similar data for a larger population, the laying interval in this case being three hours, and the females having been derived from a two-day-old culture. The percentage of delayed eggs is low, but there is an increased variability in the hatching time of undelayed ova.

The agar drops were incubated at room temperature (22.5° C) for 24 hours from the time of first exposure to the laying flies, when they were irradiated and immediately transferred to fresh culture bottles, where the larvæ developed. Conditions of back-scatter were kept constant in all experiments. The eyes of adult flies from irradiated eggs and larvæ were carefully examined for mosaic patches under a binocular stereoscopic microscope. Affected eyes were mounted in high-refractive media and studied further. Counts were independently checked in separate experiments by six workers, with good confirmation.

A single source of radiation was used, since the effect of dosage alone was studied in this work. It was a Coolidge x-ray tube of the "portable" type, air-cooled and with tungsten target, of lead glass with a sodium glass window. It was self-rectifying, and was operated directly from a line voltage of 125 v through a transformer at a potential of 85 kvp and a current of 10 ma. The distance from the outer surface of the sodium glass window to the upper surface of the irradiated material was kept constant throughout at five inches, the only variable being the time of exposure. The radiation was unfiltered except by the soft-glass window. Measurements of the energy incident at the point of exposure of the material were made with a Failla radium-compensated ionization chamber, using a collodion-graphite thimble in one case, and in the other with a calibrated Victoreen dosimeter. The output was found to be 78.1 roentgens per minute.

RESULTS

The following table, representing the combined data for all experiments, for flies only, shows the total number of eyes counted for each x-ray exposure, the number in which whitened facets were discovered, the percentage of the total which these exceptional eyes constituted, and the percentage probable error of each

determination. The percentage error was calculated for each exposure from the formula

$$P.E. = \pm 0.6745 \frac{p \times q}{n}$$

where n is the total number of eyes observed,

$$p = \frac{\text{number of affected eyes}}{n} \text{ and}$$

$$q = \frac{\text{number of unaffected eyes}}{n}$$

Exposure	Total Number*	Number Affected	Percentage Affected	Probable Error (Percentage)
Control	3,143	0	0.00	
1/4 min	1,716	2	0.12	±0.057
1/2 min	2,884	8	0.28	±0.075
1 min	4,616	23	0.50	±0.070
2 min	2,114	18	0.85	±0.135
3 min	1,740	26	1.49	±0.195
4 min	2,215	38	1.72	±0.185

* It will be noticed that the total number of eyes given is sometimes odd. This situation results from the method used in counting. To facilitate rapidity, one eye only of each fly was counted in many cases. This because of the random distribution of modified patches in right and left eyes, is considered a justifiable procedure.

Below is shown a plot of percentage of affected eyes as a function of exposure time, the points determined being represented by the center crosses, and the lengths of the vertical lines indicating the probable error of each. It will be seen that a straight line may be considered

AFFECTED EYES

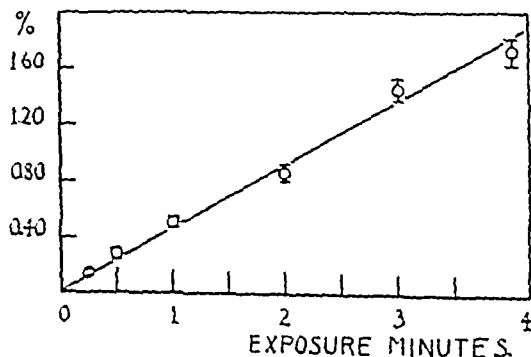


Fig. 3. Plot of percentage of affected eyes against dosage. Lengths of vertical lines indicate percentage of probable error in each determination.

the best fit for the seven points available (Fig 3)

DISCUSSION

We have indicated elsewhere the significance which the linear curve may be thought to have in genetic investigations of the volume of loci of chromosomes. It is desired here to point out one or two features resulting from it which, it is believed, indicate good adaptability of the tool as a radiation indicator.

The linearity of the curve gives considerable evidence that the end-point used results from a relatively simple transition in cell nuclei, and is effected by a less complex series of interactions than is involved in the death of the organism. The end-point sought is sharply distinguishable by trained workers. "Borderline" cases, in which the observation of the effect becomes a matter of personal variability in the observer, are excessively rare if not absent. The effect, as already stated, has been found reproducible from stock to stock of eosin, and from observer to observer, within the limits of probable error given. Whether the effect will be reproducible from one allelomorph of eye color to another remains to be determined.

It is believed that the tool may prove quite adaptable in a study of the relative effectiveness of equivalent incident or absorbed dosages of different types of energy, as well as of the same type administered under differing conditions. Thus an investigation of a possible temperature coefficient for the reaction is in progress at the moment. A study of changes of slope or form of the curve for equivalent absorbed doses of γ -rays of different quantum energies will be of interest. Such work is in progress, and is planned at four wave lengths. Locher (6) and others have indicated the importance of a study of the biological effect of neutrons, particularly because of the peculiar absorption characteristics of certain elements for them. Thus while, in the case of gamma radiation, the energy absorption of the organism is directly pro-

portional to the number of electrons present per atom, hence approximately to the atomic number of the element, in the latter it is very largely due to hydrogen atoms. In such an investigation the tool described would seem to be of use, and, due to the courtesy of E O Lawrence, R E Zirkle, P C Abersoeld, and E Dempster, work in this field has been begun. Similarly, the tool would seem to be equally adaptable to work with alpha particles, beta or gamma rays, or cathode rays.

The indicator has proved useful in connection with one or two investigations in the physiology of irradiated cells which may be mentioned in closing. Thus it is possible to derive considerable information of the relative rate of propagation of affected ("whitened") and unaffected cells from a study of the proportion of affected ommatidia in a given compound eye as a function of the number of cells in the eye anlage at the time of irradiation. Patterson, in the work already mentioned, has found that the size of mosaic spots produced varies with the age of the larva at the time of irradiation, the patches decreasing in number of elements with increasing age. We have been able to confirm this, and to further show, by direct cytological examination, that the number of cells present in the anlage at the time of irradiation corresponds rather closely to the quotient of the total number of ommatidia in the adult eye and the number affected, indicating that the rate of propagation of cells affected in the observed manner is unchanged relative to those not so affected. Thus averages of cell counts from the best sections of anlagen obtained, made perpendicular to the long axes of the elements, gave 15.6 as the mean best figure for the cell number in the primordia of larvæ between eighteen and twenty-four hours of age, reckoning from the time of laying. An average of counts of affected ommatidia in adult flies arising from larvæ irradiated at the same age, treated at exposures of one-half, one, two, three, and four minutes, involving a total of 31,734 facets, yields 12.7 as the best

figure, in reasonably close agreement. There is indication of little variability in sensitivity to x-rays for this effect as a

fied eye color in the compound eyes of imagoes of certain stocks of *Drosophila melanogaster* irradiated as eggs or young

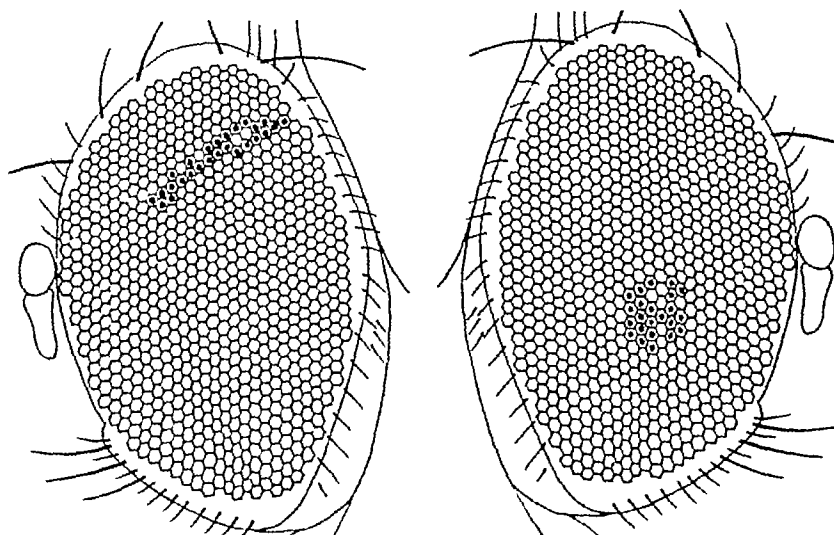


Fig 4 Diagrammatic representation of mosaic patches of variant shapes

function of age of the organism, from 18 hours onward, at least. Information of the preferred planes of division of affected cells can be obtained from a study of the shapes of mosaic patches under various conditions of irradiation. Data can likewise be obtained relative to the number of ion passages required to achieve the effect, the relation of spot size to dosage, sex, and portion of the anlage affected, as indicated elsewhere (Fig 4).

All in all, it is believed that the induction of patches of mosaic eye color in stock of *Drosophila melanogaster*, originally described by Patterson, may well prove a useful indicator in studies of the biological effectiveness of x-rays and other forms of electromagnetic and particulate energy in biological material.

SUMMARY

A description is given of an effect of x-rays in producing mosaic patches of modi-

larvæ. The effect was originally described by Patterson and has been further investigated by the present authors. It is believed that it may well constitute a useful tool in investigations of the biological effect of x-rays upon small test objects, and reasons for this viewpoint are detailed.

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ROENTGEN KYMOGRAPHIC STUDIES OF CARDIAC CONDITIONS¹

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ROENTGEN kymography is an objective and accurate method of recording the physiological movements of an organ or structure on a single x-ray

film, who, in 1915, presented his kymograph, elucidated the principles of kymography, and pointed out its application in the study of heart disease. In 1928, Pleikart Stumpf (3), of Munich (Fig 1), made and later perfected a kymograph with multiple slits. By 1931 (4) he had developed the procedure so that it was practical and of clinical value. I. Seth Hirsch (5, 6) introduced multiple slit kymography to this country in 1934, improved the technic, and made important clinical contributions. It was his work that stimulated our interest in kymography.

The procedure is simple (Fig 2). The essential part of the apparatus is a large lead sheet in which narrow, horizontal slits are cut every 12 mm apart. Each slit is 0.4 mm in width, as advocated by Hirsch. This sheet is called the "grid." In our technic it is stationary. The film or cassette is placed behind the grid, and during a single, continuous exposure of about one and one-fourth second the x-ray film slowly moves down behind the grid a distance slightly less than the space between the slits, or actually 11 millimeters. This leaves 1 mm of white, unexposed film which divides the kymogram into frames and prevents an overlapping of exposures. It must be clearly understood that it is the movements of only those areas on the border of the heart that overlie a slit which are recorded on the film as it moves down behind the grid. For a more detailed discussion of the apparatus² and discussion of the principles of kymography, the reader is referred to previous articles (7, 8) and to the papers of Hirsch and Johnson (9).



Fig 1 Professor Pleikart Stumpf, a. o. Universitätsprofessor Facharzt für Röntgen und Lichtheilkunde Munich Germany. Dr Stumpf originated multiple slit kymography and is to be credited more than anyone else with its subsequent development and application to the study of heart disease.

film. The original idea was conceived by Bronislaw Sabat (1), in 1911, when he was a physiologist in Warsaw, Poland. The American pioneer in the development of this work was A. W. Crane (2), of Michi-

¹ Presented before the Radiological Society of North America at the Twenty-second Annual Meeting at Cincinnati, Nov. 30-Dec. 4, 1936.

² Roentgen kymographs and kymoscopes are manufactured in this country by the Liebel Flarsheim Company, Cincinnati, Ohio.

Figure 3 is a kymogram of a normal heart. Each frame is a record of the movements of the small area on the heart. see that the aorta is filling outward as the result of the ventricular contraction. Other methods for determining the time

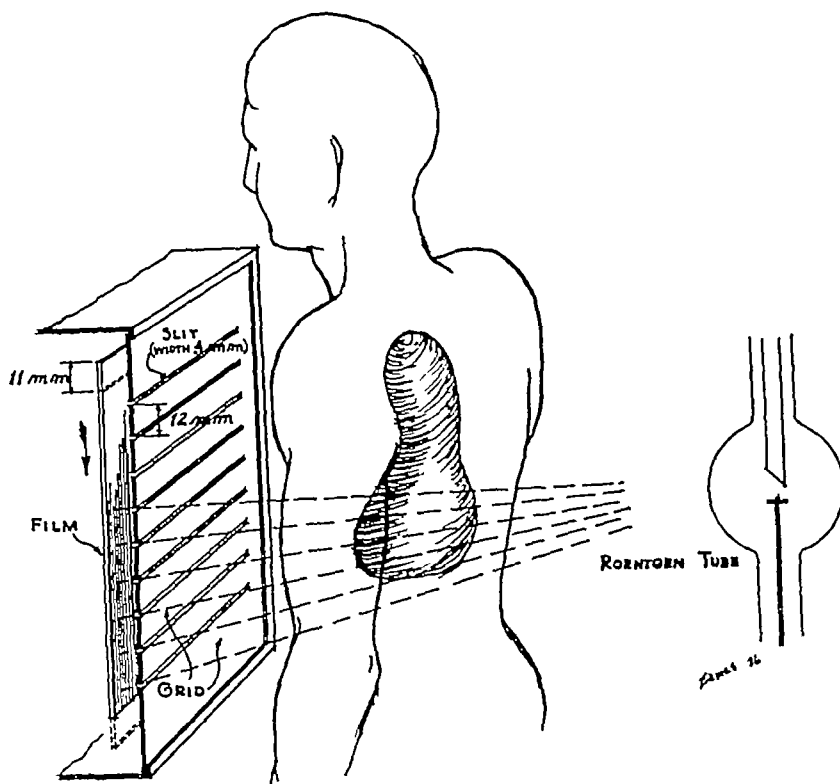


Fig 2 Diagrammatic sketch of kymograph. For cardiac work we prefer the arrangement whereby the grid is fixed and the film is moved downward behind the grid during a single continuous x ray exposure. (Modified after Stumpf.)

border which was opposite a slit during the time the heart filled and emptied. Each wave is one cardiac cycle. The lower leg of each wave is the record of diastole and the upper leg, of systole.

Since the slits in the grid are equally spaced and the film moves at a uniform rate, all points on any wave that are equidistant from a white line at the bottom of any frame, occurred at the same instant. By measuring these distances in various frames, it is thus possible to determine the time relationship of the movements that occur in the different cardiac chambers.

For example, ventricular systole begins at the peak of the waves and moves medially. If we measure this same distance from the peak to the white line at the bottom of the frame in the aortic area, we

occurrence of movements in the various cardiac chambers and great vessels are mentioned in references (8) and (10).

At this point we should like to mention that in 1926 Dr W Edward Chamberlain and William Dock (22), using Dr H E Ruggles' cinematograph, were able to make 16 x-ray films of the heart in one second. They then superimposed these films in their chronological sequence and by measuring the change in position of a series of linear points on the heart border, they were able to construct a graphic curve which was a record of the movement of these points on the heart border as it filled and emptied. It is to the credit of this ingenious experiment that Dr Chamberlain's curves are practically of the same shape and possibly more ac-

curate than those recorded by the present-day kymograph (Fig 4)

The following illustrations are a few

ing the patient to the operating room, by postmortem examinations, and by comparing one's results with those obtained by

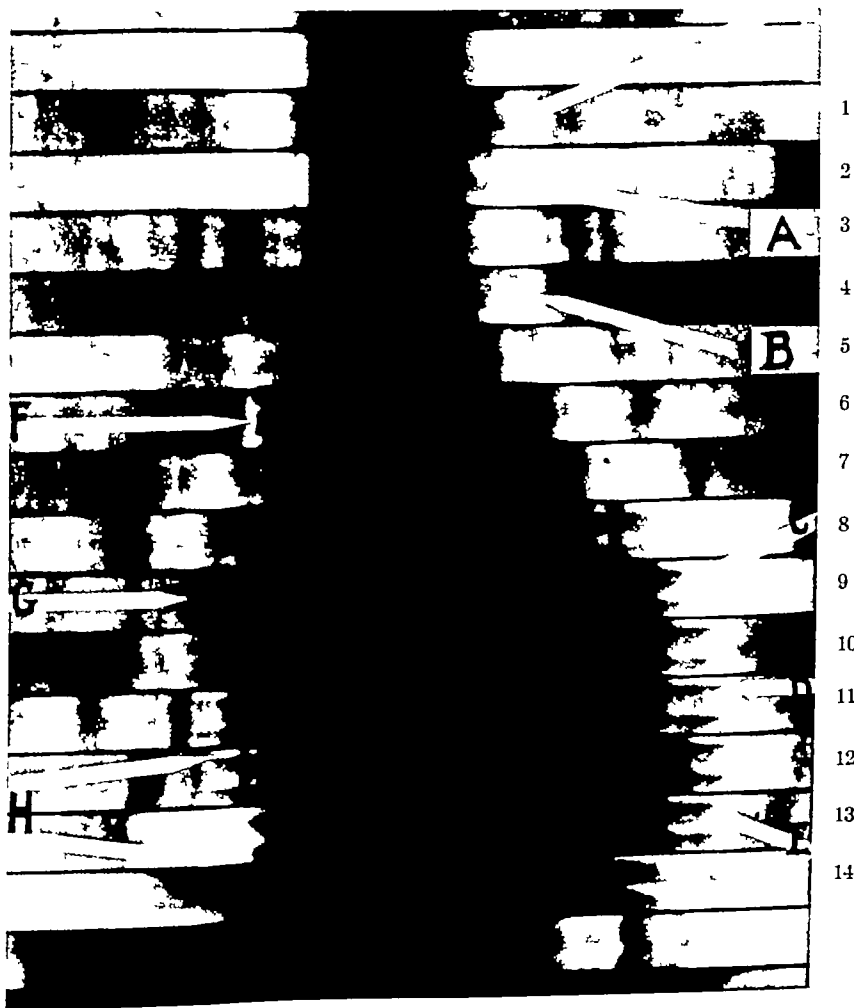


Fig 3 Roentgen kymogram of normal heart (a) Peak of aortic wave attained just after onset of ventricular systole (b) Waves produced by pulmonary artery, (c) Maximum systole at trough of wave (d) Maximum diastole at peak of wave, (e) Notch produced by systole of auricle (f) Wave produced by auricular appendage, (g) Trough of auricular wave corresponds to peak of ventricular wave, (h) Right lower cardiac border is formed by the right ventricle

Over left heart border frames 1-3 descending aorta, 4-5 pulmonary artery 6-7 left auricle, 8-14 left ventricle Over right heart border frames 1-4 superior vena cava, 5 ascending aorta, 6 auricular appendage 7-10 right auricle 11-14 right ventricle

Exposure factors 100 ma , 85 kv 28 in target film distance, exposure time one and one fifth second.

instances in which we feel that kymography is of value in the clinical study of heart disease Confidence in any new procedure is gained only through precedents which are established by follow-

others The pursuit of these objectives is always difficult and requires time before they can be agreed upon and accepted We have freely consulted the contributions of Wilke (11), Fetzer (12), Bicken-

bach (13), von Braunbehrens (14, 15), Heckmann (16), Schilling (17), Gilhes and Kerr (18), and others Stumpf and his colleagues have recently published a very excellent book which includes most of the kymographic studies done in Europe. It represents an enormous amount of work and should be consulted by all interested in this type of work.

In Figure 5-A, a kymogram of a pericardial effusion, note the very small cardiac motions over the entire heart border as the result of compression. In Figure 5-B, part of the fluid has been removed and replaced with air. The waves over the portion of the heart surrounded by fluid are small (Fig 5-C). Near the fluid level the cardiac motions are larger at the surface of the fluid very large waves are produced by the splashing fluid. Above this level the heart is surrounded by air, which permits a larger diastolic excursion as the lung is not in contact with the heart to act as a buffer. This kymogram illustrates especially well the refinement in the recording of physiological motion that can be achieved kymographically. These films also confirm the view that changes in the surroundings of the heart modify the heart action itself.

In dextrocardia (Fig 6) the position of the heart is reversed, but the movements of the chambers and great vessels are exactly the same as in the normal heart (19). Other changes in the position of the heart produced by other conditions show, on the whole, no new problems, and their movements are unaltered.

The detection of rhythmic disturbances is a mere accident because of the short exposure time of one second, unless patients are carefully kymographed with this purpose in mind and then preferably by the technic of Cignolini (20) or Zdan-sky and Ellinger (21). Ventricular extra-systole (16, 19) produces a striking kymogram showing one small wave, the extra systole, followed by a large wave (Fig 7). The large wave results from an over-distention of the ventricle produced by the prolonged filling which is recorded as a

diastolic plateau. It is the prolonged filling of the ventricle that gives rise to the compensatory pause which is felt in the

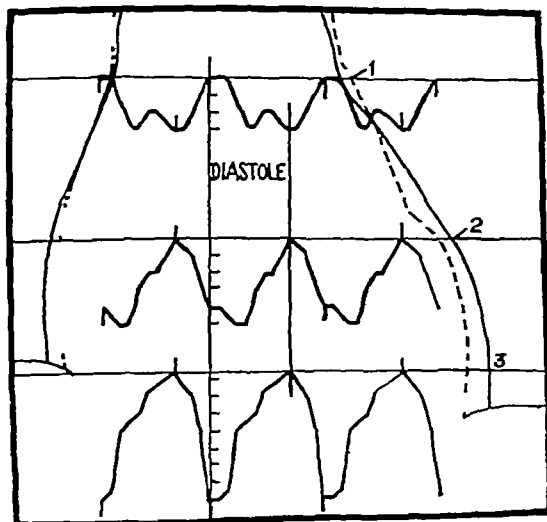


Fig 4 'Frontal projection of the normal heart at end of diastole (heavy lines) and at end of systole (dotted lines) together with skiardiograms at the points indicated by the numbers. The maximum auricular excursion (Point 1) is 3 mm, maximum ventricular excursion (Point 3) is 7.5 mm. Duration of diastole is nine fifteenth second. Duration of systole is four-fifteenth second. An up-stroke marks the beginning, a downstroke, the end of systole' (Chamberlain and Dock).

Careful measurements on kymograms of normal hearts are consistent in that diastole consumes two-thirds of the total time of one cardiac cycle. Systole consumes but one-third of the time. These findings are in close agreement with those obtained by cinematography.

radial pulse. The extra-systole is not registered on the aortic waves, which indicates that the semilunar valves were not opened.

The electrocardiogram is of great superiority in the diagnosis of arrhythmias due to its unlimited exposure time and its definite separation of auricular and ventricular movements. The electrocardiogram is a graphic record of the electrical phenomena produced in the heart muscle as it contracts and expands. Roentgen kymography is a graphic record of the movement of the heart muscle itself as it functions during the cardiac cycle. One is primarily a record of electrical impulses, the other primarily of muscle tissue. Each has advantages and limitations.

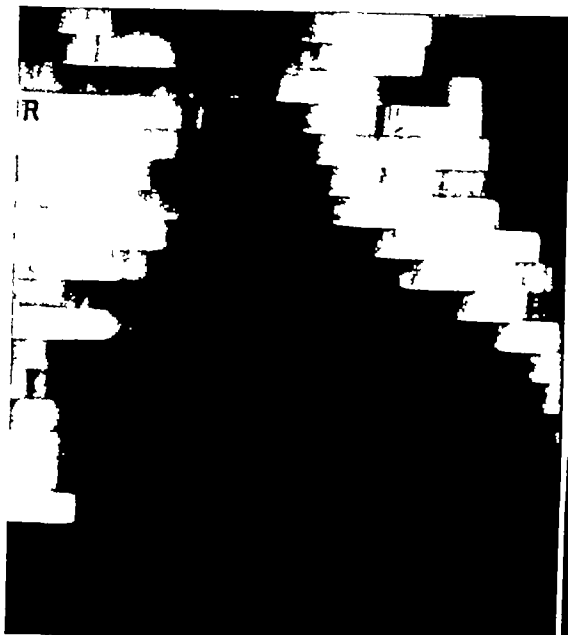


Fig 5-A



Fig 5-B

Fig 5-A Kymogram in pericardial effusion. Note the very small movement over the entire cardiac outline which constitutes the so-called cardiac compression syndrome described by Claude Beck. The decrease in the cardiac movement is due to an inability of the heart to expand during diastole.

Fig 5-B Diagnostic hydro-pneumo pericardium. Pericardial sac is not appreciably thickened. Note position of fluid level and area of heart in contact with air.



Fig 5-C



Fig 6

Fig 5-C Kymogram made at same time as Figure 5-B. In frames 1-3 aortic movements are buffered by adjacent lung; frames 4-6 large movements as heart is surrounded by air; frame 7 splashing fluid level; frames 8-10 movements of ventricle gradually decrease as apex is approached.

Fig 6 Dextrocardia. The position of the heart is reversed. The movements of the chambers and great vessels are exactly the same as in the normal heart. Compare with Figure 3.

neither replaces the other. In the kymogram of a normally functioning heart, the movement waves are of moderate size,

raphy in estimating the tone and efficiency of the heart muscle.

In decompensated hearts (17, 19, 23), a

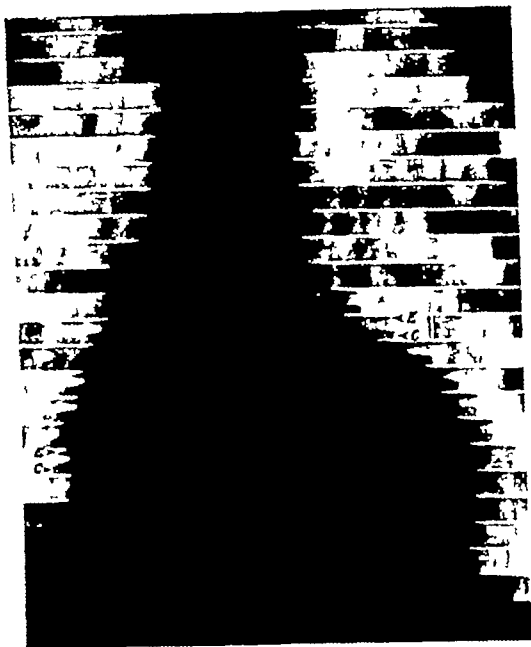


Fig 7 Ventricular extra systole. This patient was having repeated extra systoles. The extra-systole is the small wave *E*, which is following the large wave *C*. The wave, *C*, is the record of the compensatory pause produced by a preceding extra systole that is not shown in this record.

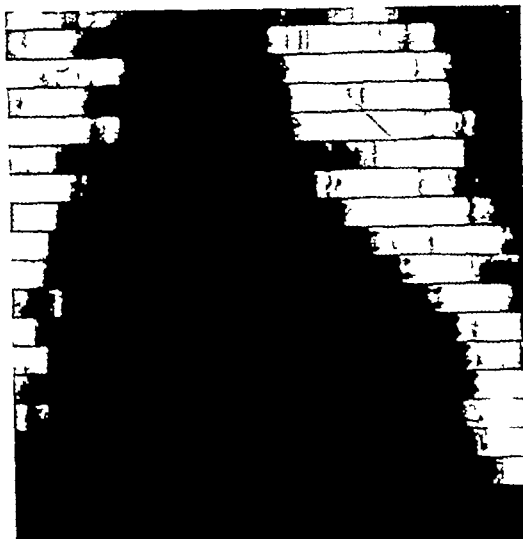


Fig 8 Kymogram of moderately advanced myocardial impairment. Patient is a 36-year old colored salesman whose chief clinical symptoms were dyspnea, precordial discomfort, and palpitation on exertion. Blood pressure 180/140. Serology negative. The electrocardiogram revealed moderate myocardial damage and a common type of bundle branch block. Note the small amplitude of ventricular motion and the small superimposed irregularities on the waves of the left ventricle.

smooth, clear-cut, and give the impression of strong, easy-going motion (Fig 3). Figure 8 is the kymogram of a 50-year-old man. The movement waves are small, their edges are ragged due to little superimposed notches and indentations. The motion of the heart muscle is hesitant, and may we say, undecided. It has been our experience that in such patients, the electrocardiographic report will read "myocardial damage," "myocardial impairment," or a like phrase. We feel that a similar diagnosis is justified from studying the kymogram, and have been making such diagnoses for several months. As to the significance of each little notch or indentation on the waves we are not prepared to state. That is one of the many problems open for future investigation. Stumpf, Faber (23) and Hirsch have previously emphasized the value of kymog-

raphy in estimating the tone and efficiency of the heart muscle. In decompensated hearts (17, 19, 23), a similar but poorer type of cardiac motion is recorded (Figs 9-A and 9-B). The waves are smaller and more ragged. After digitalization and the regaining of compensation, the motion of the heart is improved as shown by the larger, more forceful, and more clear-cut waves, together with a decrease in heart size.

Thus far we have made a kymographic diagnosis of cardiac infarction in six instances. The kymographic detection of cardiac infarcts has been previously described by others (8, 13, 14, 15). In all cases the history and electrocardiograms were characteristic of a coronary infarct. Two cases were confirmed on postmortem examination. The kymogram in Figure 10-1 shows that the area of infarction possesses no motion as shown by the straight lines, with areas of adequate motion on either side. This patient is a man, 63 years of age, who experienced an

attack of severe precordial pain ten days prior to admission. The electrocardiogram showed evidence of coronary

coronary artery passes along the inter-ventricular sulcus on the anterior surface of the heart and around the apex and up

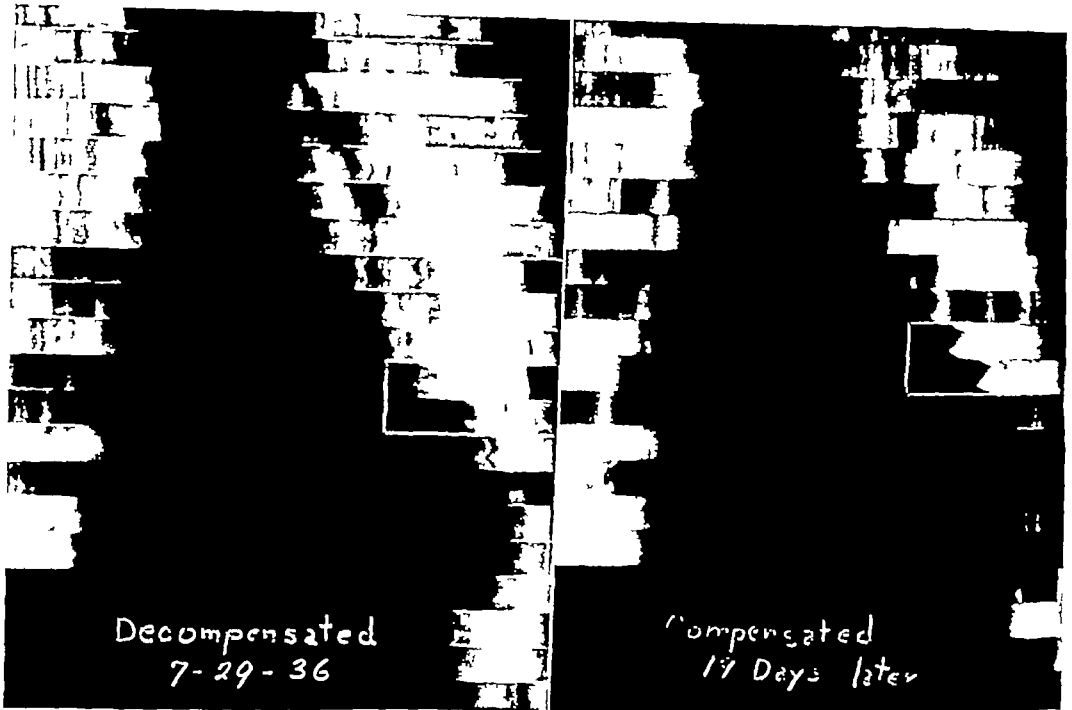


Fig 9-1

Fig 9 B

Fig 9 A The heart in decompensation. The amplitude of ventricular contraction is small. The ventricular waves are ragged, indicative of a poorly functioning myocardium.

Fig 9-B The heart after regaining compensation. The patient was fully digitalized. The contractions of the left ventricle are now larger, more forceful and clear-cut. The heart is smaller. Both films made with the same technic.

occlusion. Repeated kymograms showed this persistent defect as demonstrated in Figure 10-B, made 12 days later or 22 days following the occlusion. Note the improved cardiac tone with the return of slight motion at the site of infarction.

It is hoped that in the future kymography may prove of value as a means of demonstrating areas of cardiac infarction. Paul White (24) states that, "The commonest site of cardiac infarction is the descending branch of the left coronary artery and as a result has been called the 'artery of sudden death' or 'the artery of cardiac infarction'." The second most likely spot for infarction is the posterior wall of the left ventricle near the base, due to occlusion of the right artery." The posterior descending branch of the left

the posterior surface for a short distance. Thus it is quite possible to make kymograms in positions which will outline this portion of the heart muscle.

The kymogram shown in Figure 11-A is that of a 38-year-old man who experienced severe precordial pain three days prior to the making of the film. Note the small movement of the entire left ventricle, a finding which Stumpf (19) states occurs with coronary infarction. The patient died three days later, and at postmortem a fresh infected infarct was found in the left ventricular wall near the apex (Fig 11-B). There also was an older softened infarct in the posterior wall of the left ventricle just below the aortic valve. Only a small segment of uninvolved cardiac muscle separated these infarcts at one level.

These findings explain the poor movement of the left ventricle

These two cases illustrate that each

1 Hypertension alone does not produce increased movement of the ascending aorta

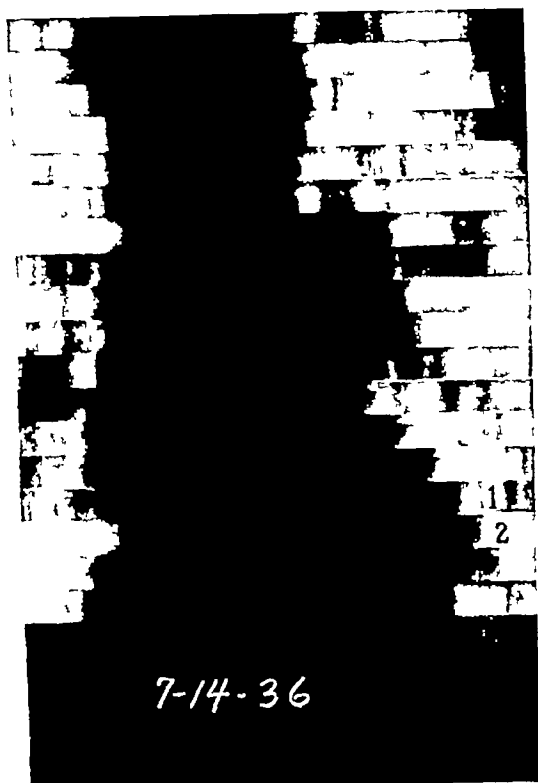


Fig 10-A Kymogram demonstrating an area of cardiac infarction. The area of cardiac infarction is recorded in frames 1 and 2. This area is without motion as shown by the straight lines with areas of adequate motion on either side.

heart is an individual problem and must be analyzed and studied as such, which requires experience in this field.

Following a suggestion by Dr. Merrill Sosman, of the Peter Bent Brigham Hospital in Boston, we undertook a critical study of the movements of the ascending aorta in patients with hypertension, arteriosclerosis, and syphilitic aortitis to determine whether or not they could be differentiated kymographically. The chart showing the results of this study is seen in Table I. Our observations are in accord with those expressed by Stumpf (19) and others, and are briefly summarized as follows:



Fig 10-B Kymogram of same patient made 12 days later and 22 days following the coronary accident. It shows an improved cardiac tone with a return of slight motion at the site of the infarction.



Fig 11-A Kymogram made three days following coronary occlusion. It differs from Figure 10-1 in that the movement of the entire left ventricle is greatly diminished.

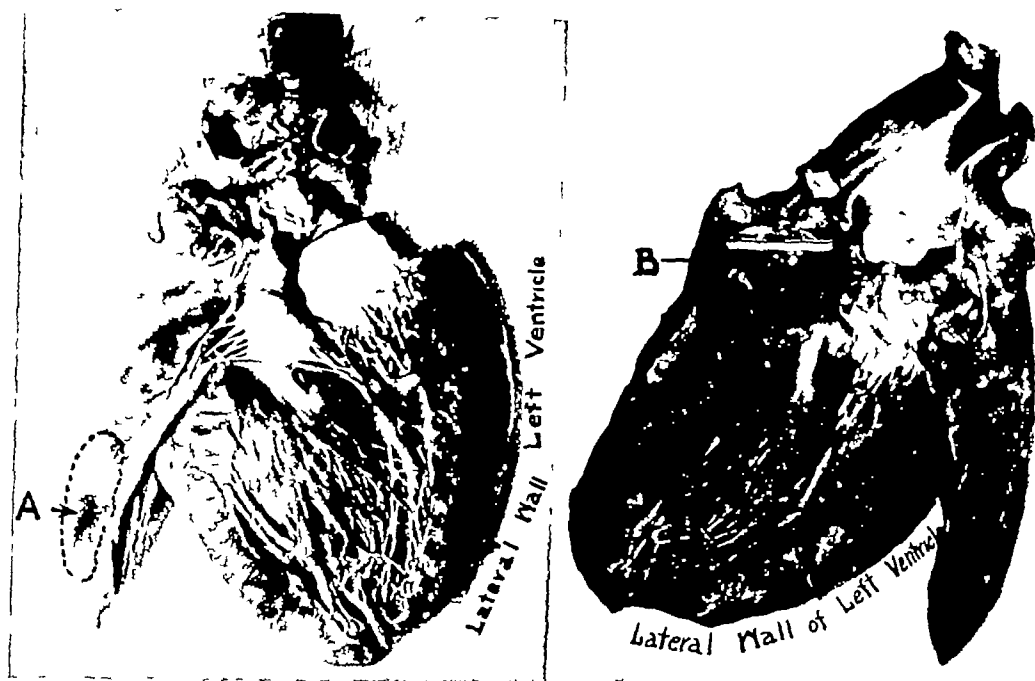


Fig 11-B Photographs of heart showing zone of fresh infarction near apex of left ventricle and a softened infarct on the posterior wall of the left ventricle secondary to an acute bacterial endocarditis A fresh infarct B, old softened infarct

2 Arteriosclerotic changes produce large movement waves over the ascending aorta which for the most part are the result of a shift in the position of the aorta during a cardiac cycle, just as a loop of garden hose tends to straighten out as water is suddenly forced through it

Kymograms made in the right and left anterior oblique positions are necessary to distinguish this type of positional change from expansile motion seen in syphilitic aortitis. In motion due to positional change both sides of the aorta shift in the same direction at the same instant. In expansile

TABLE I—MOVEMENTS OF ASCENDING AORTA

Diagnosis	No	Age	Increased Motion of Ascending Aorta	Type of Wave over Ascending Aorta
Normal Hearts	50	Youngest 18 Oldest 67 Average, 34	0	
Arteriosclerotic Heart Disease	25	Youngest 44 Oldest, 83 Average 58	22	Not distinctive Due to shifting position of aorta.
Hypertensive Heart Disease (without complications)	25	Youngest 29 Oldest 74 Average 52	3	Not distinctive.
Syphilitic Aortitis	50	Youngest 28 Oldest 70 Average 44	Total 22 Slight 7 Large 15	Not distinctive In young adults waves may be pyramidal Expansile.

motion the two sides of the aorta bulge outward at the same instant and move medially together



Fig 12 Syphilitic aortitis In nearly all cases of definite syphilitic aortitis there is observed the prominent bulging of the ascending aorta to the right Kymographically the presence of large aortic waves in this area is most suggestive of syphilitic involvement in individuals of 40 years of age or under even in the posterior anterior view This patient was a 20-year-old colored female who complained of dyspnea and substernal pain Serology 4 plus Blood pressure 110/70 She had received antisypilitic treatment for the past two years

3 Syphilitic aortitis (Fig 12) gives rise to large movement waves in less than 50 per cent of the cases diagnosed clinically These waves are not distinctive from those seen in arteriosclerosis The presence of large waves over the ascending aorta in adults below forty is most suggestive of syphilitic aortitis, and may be considered as such kymographically

In the differential study between arteriosclerotic changes in the aorta and those produced by syphilis, one of us (H A McC) first suggested that the large movements over the ascending aorta seen in syphilitic aortitis were the result of a destruction of the elastic fibers in the media of the vessel wall This permits these portions of the aorta involved to bulge outward a distance farther than normal

during aortic filling Figure 13 is a photomicrograph of a section taken from a case of syphilitic aortitis which showed, kymo-



Fig 13 (upper) Photomicrograph of section of aorta involved by syphilitic changes The elastic tissue is stained black Two large white scars interrupt the elastic tissue of the media near the center of the picture The media shows fibrous thickening

Fig 15 (lower) Photomicrograph of arteriosclerotic changes in aorta, elastic stain The black elastic fibers of the media are intact In the intima on the left hand side, there is a large arteriosclerotic plaque which contains calcium and cholesterol crystals

graphically, enlarged movements over the aorta The elastic fibers are disrupted and broken

In arteriosclerosis (Fig 14) the elastic fibers remain intact but are unable to function normally in areas where sclerotic or hyaline plaques are deposited in the intima These changes may be compared to an elastic band upon which a few flattened rigid objects have been cemented in the unstretched state The portions of the elastic band under the cemented areas cannot be stretched, but the free intervening segments retain their elasticity

through an arteriosclerotic plaque in the aorta and demonstrates these intimal changes with the elastic fibers of the media

distinguish between inherent expansile motion or movement due to a shifting in the position of the aorta. Fourth, it

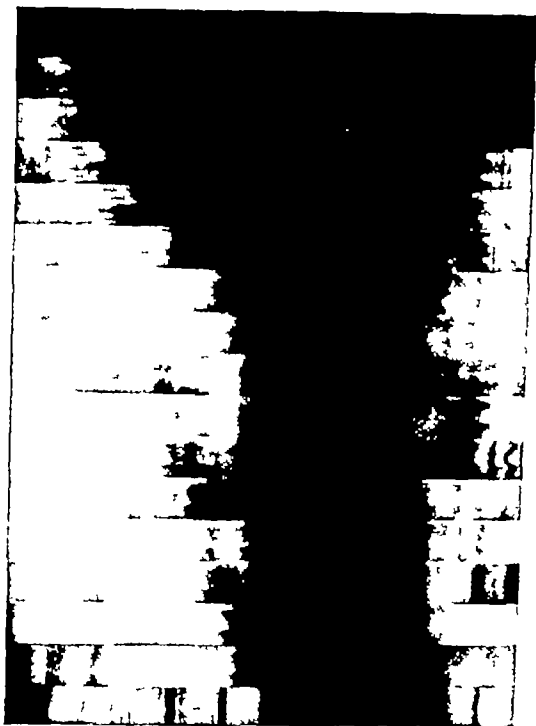


Fig 14 Arteriosclerosis. Cardiac silhouette is not enlarged but the aorta is considerably lengthened. The large waves over the ascending aorta are produced by positional change as can be demonstrated in the oblique views. Patient is a 70-year-old woman. Blood pressure, 230/110. Serology, negative.



Fig 16 Hypertensive heart disease in a young individual shows little or slight increase in movement of the ascending aorta. Hypertension itself seldom produces a noticeable increase in the size of the aortic movements. The heart is usually enlarged and the aorta is slightly widened. Patient is colored female, 29 years of age. Blood pressure 238/130. Serology negative.

remaining intact. Stumpf (19) maintains that in arteriosclerosis the aorta consistently shows less movement.

The kymogram in Figure 16 is that of a colored female, 29 years of age, with a hypertension of 238/130. The movements over the ascending aorta are not in excess of those shown in many normal hearts.

In the study of aortic movements certain errors in technic and interpretation should be guarded against. First, the patient must not breathe during the exposure as the movements of breathing exaggerate the aortic motion. Second, aortic movements are influenced by the pulse pressure, curve of aorta, structure of aortic wall, and by the width of the aorta. Third, oblique kymograms are necessary to

must be appreciated that the curve of aortic filling is a record of ventricular systole, and that the curve of ventricular systole must be studied before evaluating changes in the aortic waves.

The literature contains occasional references concerning the presence of separate liver pulsations. In pneumoperitoneum (Fig 17) the right diaphragmatic leaf and the liver are separated by air and the movements of each can be recorded. The small pulsations at the liver are of the same shape, size, and time occurrence as those of the diaphragm and intestines. Stumpf (19) considers this as ample evidence that normally the liver does not pulsate differently from contiguous organs.

The accurate diagnosis of a cardiac aneurysm is a very difficult task even when aided by all the mechanical equipment available in the modern hospital. Von

Braunbehrens (14) first reported the kymographic diagnosis of a cardiac aneurysm. In Figure 18-A the usual type of chest film

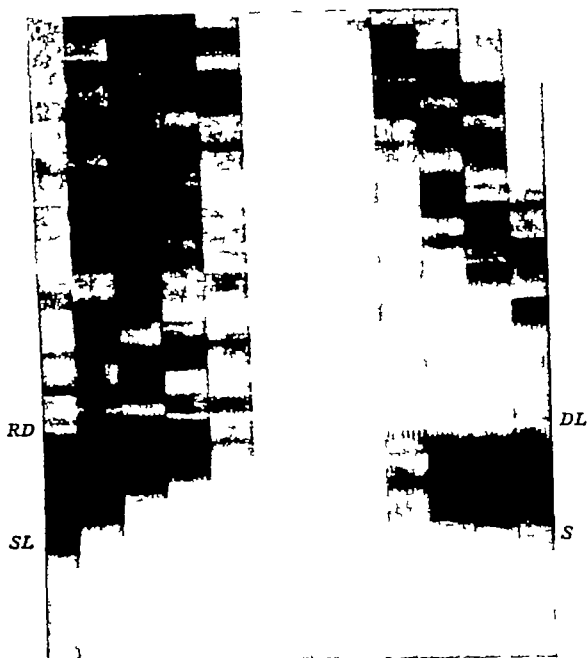


Fig 17 Artificial pneumoperitoneum. The pulsations over the superior border of the liver are of the same shape, size, and time occurrence as those recorded by the diaphragm and stomach. RD, right leaf of diaphragm; DL, left leaf of diaphragm; SL, superior border of liver; S, superior border of stomach.

is shown, which includes the outline and size of the cardiac silhouette. On the border of the middle third of the left ventricle is a hemispherical outpouching about the size of an English walnut. Fluoroscopically, it was debated by several clinicians as to whether or not this tumefaction moved synchronously with the heart or *vice versa*. The diagnoses involved included a tumor of the heart, a tumor in the adjacent lung-field, and a cardiac aneurysm. The kymogram (Fig 18-B) settled the question and established the diagnosis of an aneurysm of the left ventricle.³

³ Since submitting this paper for publication, this patient died and an autopsy was performed. Much to our surprise, a highly malignant tumor, rising from the endothelium of the pericardium, was found at the site of the tumefaction, refuting the diagnosis of a cardiac aneurysm. Here again is a reminder of the extreme difficulty in distinguishing between an aneurysm and a tumor. These kymographic and pathological findings are most instructive and will therefore, be reported in detail in a future publication.



Fig 18-A Postero-anterior roentgenogram of chest illustrating the area of tumefaction on border of left ventricle which was considered as an aneurysm of the ventricle.

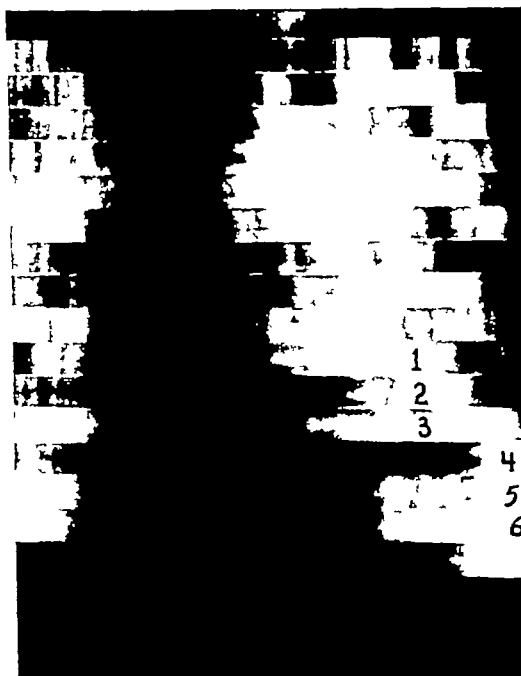


Fig 18-B Kymogram demonstrating aneurysm of left ventricle. The movements of the uninvolvement ventricle are recorded in frames 1, 2, and 3. The movements of the aneurysm are in the opposite direction and are shown in frames 4, 5 and 6. The time relationship is accurately established by measuring the distance from the black line at the bottom frame over the ventricle to a particular wave and then measuring this same distance in a frame over the area of the tumor.

The tumefaction is objectively recorded as bulging outward (laterally) at the same moment the remaining portion of the ventricle is in the medial position at systole. During diastole, the tumefaction is in its medial position (trough of the wave), while the other portions of the ventricle are in the lateral position (peak of the wave).

CONCLUSIONS

In conclusion we wish to emphasize a few kymographic principles that have been of help to us in interpreting these films.

1 Kymography is primarily a picture of the physiological motion of an organ or structure.

2 The kymogram will be varied from the normal only insofar as a heart lesion will alter the movement of the heart muscle.

3 Movements of the heart are altered by certain diseases of the valves, by changes in the pericardium, alterations in the pericardial contents, changes in the heart muscle producing variations of muscle tone and efficiency, and occasionally, by changes of rhythm.

4 The clinical evaluation of kymography at present is difficult because of its infancy and the relatively few men using the procedure. It must be considered as another aid in the diagnosis of heart disease and viewed somewhat modestly as helpful and supplementary to the average heart diagnosis, but not accorded too much importance. In a few instances kymography will be the means of establishing a difficult and obscure diagnosis.

5 The assembling of facts and their comparison with clinical methods is the important problem of the future.

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DISCUSSION

DR C L GILLIES (Iowa City, Iowa) As Dr Scott has told us, the principle of roentgen kymography is not new. Its possibilities as a diagnostic aid in the study of the heart and great vessels have long been appreciated. The popularity that the method is beginning to enjoy is not so much due to improvement in kymographic apparatus as to increased speed in radiography, which permits using narrower grid slits and faster grid or film movement. This produces better definition of outline on the kymogram and allows the wave forms to be spread out so that they can be better analyzed. It is now possible, also, to make satisfactory lateral and oblique views not formerly obtainable.

The aid of the kymograph in the diagnosis of cardiac infarcts, certain valvular lesions, and in differentiating solid tumors from pulsating aneurysms is well established. This is not true of all disease, for while valvular and myocardial damage should produce alterations in the kymographic record, some of these changes are not now recognized or well understood. It is only through the careful study of groups of cases, such as have just been presented, that we may become familiar with and able to recognize these abnormal wave forms.

Therefore I feel that this and other papers by Dr Scott and Dr Moore will not only increase the interest in kymography, but that their contributions on interpretation will serve as a guide to those of us who have not had the opportunity or industry to make similar intensive studies.

DR AUGUSTUS W CRANE (Kalamazoo, Mich.) It is a real privilege to hear this paper and to discuss it.

I think it is somewhat confusing to anyone to look at the roentgenologic exposure of the kind you have been seeing. Obviously, the interpretation of such views will take a great deal of time. When you think of the enormous amount of labor which has gone into the interpretation of

the electrocardiogram, you can realize that the full meaning of these kymographs will not be immediately evidenced.

The original kymograph, as you know, was a single slit with the passage of the screen or the x-ray film or, at that time it was an x-ray plate—a passage of considerable length—so that you had a tracing going the entire length of the film—or, I should say, the plate. (We get so used to speaking of films!)

That gave a tracing which could be compared to the sphygmographic tracings such as Sir James MacKenzie used to make, or the tracings of the electrocardiogram.

I think if there is any one criticism which might be made of the present method it is the brevity of the curve, of the tracing. It takes in a single impulse or at the most two, unless we have a tachycardia, in which case you may get more.

It is obvious that when it comes to arrhythmias such as auricular fibrillation or heart block or extra-systoles, these tracings may give you confusing information. You could hardly recognize the true character of the beat if you happen to get the extra-systole at the time of exposure. You would have to take more than one view.

It still seems to me highly desirable that this method should be such that we are able to get curves of considerable length showing the heart in motion over a longer period of time. It has, however, the great value of showing the entire border of the heart on both sides.

It is obvious that the x-ray method is the only method whereby you can study simultaneously the muscle movements of more than one chamber of the heart. Perhaps I should not say quite that, because the sphygmographic tracings of the radial pulse at the same time you get an impulse from the jugular vein in the neck give you a polygraphic tracing for comparison. Those tracings represent, of course, the pressure impulse from the heart, something different from muscle movement.

In the electrocardiogram you get no

separation of chambers excepting the auricles and ventricles. You get the mass muscle movement in one end of the heart and the mass muscle movement at the other, or rather, you get not the movement but the electrical potential. However, by roentgen kymography if we were to rotate the patient, we could get the pulsations of the right ventricle and the left ventricle simultaneously, or the right auricle and the left auricle or the aorta, and I think there is no method yet devised which is so authoritative in distinguishing between a mediastinal tumor and an aneurysm—sometimes a matter of very great importance.

I think you have listened to a very masterly paper and in its present form it will be a very distinct addition to the examination of the heart, although we must say that there is no organ of the body which presents itself for so many kinds of examination as does the heart. We can listen to it, we can feel its pulsations and see them on the x-ray screen, we can get the electrical potential on the electrocardiogram, we can get the tracings of the venous and left ventricle tracings with the sphygmograph. Is there any other organ of the body that allows so many different types of examination?

Yet I think the internist will agree that he never knows too much about the diseased heart. For that reason I think

that the cultivation of this method by the roentgenologist is fully warranted.

I am sorry that I did not express my appreciation a few moments ago of that very excellent paper on the duodenum. My attention was taken up with the primary carcinoma of the duodenum.¹

DR SCOTT (closing). It has been a great pleasure to hear Dr Crane tell about his early work. It represents a truly remarkable piece of mechanical ingenuity. At the time it was started there were only two articles in the German literature, and neither contained more than a diagrammatic outline of the principles of kymography. From this inadequate description Dr Crane constructed a superior apparatus. His records represent a great improvement. His work commands our highest respect.

I am much pleased with what Dr Chamberlain had to say about kymography and its possibilities. His interest in cinematography makes it possible for him to evaluate better the practical applications.

We appreciate also Dr Gillies' discussion and are looking forward to his further reports.

I regret that Dr Moore has been unable to be here and to participate in this discussion.

¹ Malignancy Involving the Duodenum. Allan Tuggle and Sidney Weintraub. To be published later.

THE USE OF PENTOBARBITAL SODIUM FOR ROENTGEN NAUSEA AND VOMITING¹

By WALTER C POPP, M D, Section on Therapeutic Radiology, and MELVIN W BINGER,
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NAUSEA and vomiting as a complication of roentgen therapy has been the concern of the radiologist since the advent of this mode of treatment. The causes of roentgen sickness are not definitely known, whether it is a toxic effect on the higher centers or a reflex action over the sympathetic or parasympathetic system has not been absolutely established. To overcome this complication many therapeutic agents have been tried but, because of their failure or their expense, they have fallen into disuse. As an empirical measure one of us (M W B) prescribed a sedative to be taken at each session of treatment. As a result of this trial there was definite evidence of relief from the severe sickness which commonly attends roentgen therapy.

Following this experience, many different sedatives were tried in the hope of finding one with a sedative action sufficiently rapid that the patient might be under fairly good sedation during the interval in which radiation sickness usually occurs. After the experimental use of several drugs, pentobarbital sodium was decided upon because of its rapid sedative effect. The successful use of barbiturates to overcome vomiting, sea sickness, or migraine were reported by Wolfram as early as 1906. Experience has also taught that these drugs relieve the nausea, vomiting, or convulsions of uremia due either to primary nephritis or to severe terminal hypertension. In general, they are used extensively for relieving migraine, epilepsy, anorexia nervosa, and many of the functional disorders of the nervous system. As with all barbiturates, pentobarbital sodium is a powerful hypnotic. Its

action is chiefly central, and in effect it is a depressant to cerebral activity and diminishes sensory irritability in proportion to the amount administered. It is difficult to say whether or not the drug has a direct action on the autonomic nervous system other than through central association.

Because the majority of our patients are ambulatory, it was rather difficult to determine the best method of administration. Very few of the patients were hospitalized, so that oral administration was rather difficult. If a patient took the drug before treatment, there was considerable sedation at the termination of treatment and the patient could not be permitted to return to his or her living quarters unattended. If the capsule was prescribed after treatment, nausea and vomiting frequently seemed to be precipitated by the ingestion of the capsule itself. For a time two capsules of one and one-half grains (0.097 gm) each were given by rectum, this seemed to yield the best results and the method of administration of the drug was therefore not responsible for the vomiting. Through the courtesy of the manufacturer of this drug we were able to procure a large number of rectal suppositories containing 3 grains (0.2 gm) of pentobarbital sodium and, after the early trials, these were prescribed almost routinely. In twelve cases suppositories containing 4 grains (0.24 gm) of pentobarbital sodium were used, but in practically every case the sedative effect was too great and it became necessary to resort to smaller doses of the drug. Since practically every adult patient can tolerate 3 grains of the drug by rectum, we have concluded that this dose is sufficient in the average case (2).

Richards and Peters have recorded their results with pentobarbital sodium or "nembutal" in 40 cases, and they felt that in

¹ Read by Dr. Popp before the Radiological Society of North America at the Twenty-second Annual Meeting at Cincinnati, Ohio, Nov. 30 to Dec. 4, 1936.

the majority of instances the use of this drug is definitely indicated. Our further experience coincides with theirs in that a very small percentage (probably 1 or 2 per cent) of patients do not tolerate the barbiturate preparations. Trostler reported three cases of porphyrinemia and porphyrinuria as a complication to the administration of barbiturates in conjunction with roentgen therapy. In 275 cases we have seen no complication whatever and, except for the problem of over-dosage, as found in 12 cases, we have observed nothing that could be regarded as a contraindication. With the exception of two cases of brain tumor, we have selected for this report cases in which large doses of roentgen rays were to be given to some part of the thorax or abdomen. In our experience it is in this type of case that roentgen sickness almost always occurs.

In this study 275 patients were given pentobarbital sodium either by mouth or by rectum. Of these 275 cases, however, only 175 are included in this report, the other 100 had to be discarded because of incomplete information, either because the patient did not use the drug routinely or because he was unable to give satisfactory information concerning its effect.

Of the group of 175 patients, 27 were treated with roentgen rays generated at 200 kv, and 148 were treated with roentgen rays generated at 135 kv. Of the patients treated at high voltage (200 kv), four received pentobarbital sodium by mouth, 23 by rectum. Of the 148 patients treated with moderate voltage (135 kv), 35 received pentobarbital sodium by mouth, 95 by rectum, and 18 by both oral and rectal administration.

Of the 27 patients treated at high voltage, 14 were treated for carcinoma of the cervix, one for cord tumor, ten for malignancy of the abdomen, and two for brain tumor. Of the 14 patients treated for carcinoma of the cervix, 11 received six sessions of treatment, three, more than six sessions. One received pentobarbital sodium by mouth, with complete relief of nausea and vomiting. Of 13 who received

pentobarbital sodium by rectum, seven obtained complete relief of nausea and vomiting, and six had only moderate nausea.

The one patient treated for cord tumor had six sessions of treatment. This patient received pentobarbital sodium by rectum and had only moderate nausea.

Of the ten patients treated for malignancy of the abdomen, six received six sessions of treatment and four received more than six sessions. One patient, who received pentobarbital sodium by mouth, was completely relieved of roentgen sickness, of the nine other patients, who received pentobarbital sodium by rectum, four derived complete relief, three had only moderate nausea, but the symptoms of the other two apparently were not influenced.

Each of the two patients treated for brain tumor received six sessions of treatment. Both were given pentobarbital sodium by mouth, one deriving complete relief and the other having only moderate nausea.

Of the 148 patients treated at moderate voltage (135 kv), 110 were treated for carcinoma of the breast, 13 for lymphoblastoma, 18 for malignancy of intra-abdominal structures, six for carcinoma of the testis, and one for arthritis. Of the 110 patients treated for carcinoma of the breast, three received three sessions, 100 received six sessions, and seven received more than six sessions of treatment. Of this group, 25 received pentobarbital sodium by mouth, with complete relief in 14 cases, moderate nausea in three, nausea with slight vomiting in three, and with no relief in five. Sixty-eight of the 110 patients received pentobarbital sodium by rectum, with complete relief in 44 cases, moderate nausea in seven, nausea with slight vomiting in 11, and no relief in six. The remaining 17 patients in the group received pentobarbital sodium by mouth, and then later by rectum, with complete relief in 14 cases and moderate nausea in three.

Of the 13 patients treated for lymphoblastoma, one received six sessions of treat-

ment, 12 received more than six sessions. Of this group, three received pentobarbital sodium by mouth, two with complete relief and one with only moderate nausea. The remaining ten received pentobarbital sodium by rectum, with complete relief in four cases, moderate nausea in three, and nausea with slight vomiting in three.

Of the 18 patients treated for carcinoma of the abdomen, two received three sessions, 12, six sessions, and four more than six sessions of treatment. In this group, seven patients received pentobarbital sodium by mouth, with complete relief in two cases, moderate nausea in one case, nausea with a slight amount of vomiting in one, and no relief in three cases. Eleven patients received pentobarbital sodium by rectum, with complete relief in seven cases, moderate nausea in two, nausea with slight amount of vomiting in one case, and no relief in one.

Of the six patients treated for carcinoma of the testis, all received more than six sessions of treatment. In this group, five received pentobarbital sodium by rectum, showing complete relief in four cases and moderate nausea in one case. One patient received pentobarbital sodium by mouth, later supplanted by pentobarbital sodium by rectum, complete relief was obtained. The one patient treated for arthritis received six sessions of treatment, pentobarbital sodium was given by mouth, with complete relief.

Of the total patients in this series, 43 were given their first two sessions of treatment without pentobarbital sodium, but the remaining sessions of treatment were given with pentobarbital sodium. Of this group, 27 were very markedly improved with pentobarbital sodium, but 16 showed very little change in the roentgen reaction.

Of the total patients, 18 received pentobarbital sodium by mouth for the first several days and showed considerable roentgen reaction. The oral administration of pentobarbital sodium was supplanted by rectal administration and 17 patients showed complete relief, with no change in one case.

Only seven patients in this series gave evidence of too much sedation and five of these had been given 4 grains of pentobarbital sodium by rectum. This indicates that probably only two patients in the entire series of 175 showed too much sedation on an average dose.

The 10 per cent of failures occurred mostly in those cases in which sedation was not adequate. It may be assumed, therefore, that with adequate sedation or by alteration in the method of administration, at least a part of these failures might be overcome.

SUMMARY AND CONCLUSIONS

Roentgen sickness is an annoying complication following roentgen therapy. Careful study of 175 patients who had received pentobarbital sodium, in all of whom nausea and vomiting was expected to occur after treatment, revealed that 61.1 per cent received complete relief from roentgen sickness, 18.3 per cent had only moderate nausea, 10.9 per cent had nausea with very slight amount of vomiting, and and 9.7 per cent obtained no relief. We found that the administration of 3 grains (0.2 gm) of pentobarbital sodium as a suppository immediately following a session of treatment was most successful. Since pentobarbital sodium is easily available, inexpensive, easily administered, and in our experience without harmful effects, we feel that its use in controlling roentgen nausea and vomiting is definitely indicated.

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DISCUSSION

DR I S TROSTLER (Chicago) In view of the fact that mention was made of my recent warning relative to the use of the barbiturates during the application of roentgen therapy, may I state that I do not think that the cases I reported in any sense are comparable to the administration of a single dose of the drug mentioned by the essayists

The cases I reported as having shown erythemas during the administration of this kind of medication were taking allonal as a general sedative and the patients were all more or less under the influence of that drug They all had sufficient effect of that drug to quiet and control nervous manifes-

tations of thyrotoxicosis or of menopausal neuroses I have heard of one more such instance—of the production of erythema under similar circumstances—since I came to Cincinnati and I wish to reaffirm my warning

DR WALTER C POPP (closing) I quite agree with Dr Trostler that a number of patients will develop a light sensitivity as a complication while using barbiturates It is my impression that this number of patients is small and when porphyrinuria and porphyrinemia develop, it is usually after prolonged use of the drug

In our experience with 275 cases, using one of the barbiturates, no such complication has been seen

HEAT AS A SENSITIZING AGENT IN RADIATION THERAPY OF NEOPLASTIC DISEASES¹

By WILLIAM H MEYER, M D , Professor of Radiology in the New York Post-graduate Medical School and Hospital of Columbia University,

and

ARTHUR MUTSCHELLER, Ph D , Physicist and Instructor of Physics in the New York Post-graduate Medical School and Hospital of Columbia University, *New York City*

PART I—INTRODUCTION

THE relatively greater sensitivity of certain types of neoplasms, as compared with the neighboring normal tissue, is undoubtedly an all-important factor in the successful treatment of certain malignant diseases

The regression obtained by means of radiation therapy in practically all of the various types of lymphomas is, of course, ascribable to the relatively greater radiosensitivity of these lesions, and, therefore, the dosage can be kept well below that which might result in serious damage to normal tissue

The difficulty arises when a given pathologic process is resistant to radiation therapy with a sensitivity approaching that of neighboring normal tissue. Unfortunately, the latter is all too often true in most of the adult types of carcinoma

Of the different methods suggested to increase the sensitivity of the more radio-resistant types of neoplasm, the thought has occurred to the writers that heat might be employed as a simple and practical sensitizing agent

In reviewing the literature, we came upon an article by Charles Miller (1) in which, by the combined use of radiation therapy and diathermy, a claim of the more beneficial utilization of x-radiation, with better resorption of destroyed tissue,

is made. In another article by E. Dubowy (2), on the effect of temperature on the biological reaction of x-rays, but little influence on the larvæ of *Drosophila melanogaster* is admitted

In view of the foregoing, we turned our attention in this direction. Furthermore, there have been some rather extravagant claims made by manufacturers of diathermy and short wave machines. Above all, we had a strong desire to determine whether or not heat can be employed to increase the sensitivity and thereby the effects of radiation therapy of neoplastic disease

DIRECT HEATING METHOD

Our first effort was to determine, if possible, the influence of direct heat application during radiation therapy. For this purpose, a heating unit was devised in which reasonably accurate thermometric measurements could be made. The heating unit consists of a circular ring of bakelite (Fig. 1) about one and one-half inches in diameter and two millimeters thick. The ring, supplied with inlet and outlet tubes at opposite sides, is covered with thin sheets of celluloid, forming a flat, disc-like chamber. Various tests revealed the fact that this disc, when filled with water, showed an absorption equal to about 0.25 mm of aluminum when from 100 to 130 kilovolts with no filtration was employed.

Direct reading thermometers were incorporated with the mercury bulbs close to the inlet and outlet ends of the heating unit. By experimentation we found that a patient could tolerate for a minimal period of ten minutes, a temperature of 115 degrees Fahrenheit, measured in the circulating water at the inlet thermometer. At

¹ Read by title at the Twenty-second Annual Meeting of the Radiological Society of North America, at Cincinnati, Nov. 30-Dec. 4, 1936.

The physical experiments were conducted with a Westinghouse short wave machine. It was through the kind co-operation of this company that this work was made possible. Some of the expense incurred in the treatment of deserving indigent neoplastic cases was met through a fund supplied by the St. Mark's Ladies Aid Society.

DISCUSSION

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second, produce heat, depending on the resistance of the substance and the current passing through it, in the sense of Joule's law, it is proportional to RI^2 . Hence, the resistance in the path of the current causes its dissipation into heat and, therefore, contact between the electrodes and the patient is usually made directly and with the aid of soap lather or saline solution which, in order to be effective in reducing resistance losses, should have a conductance better than that of a 10 per cent KCl solution (3).

Evidence and clinical observations point to the fact that, with short wave frequencies of from 2 to 10 million cycles per second, the heating is not caused by the direct conduction of current in the same way as with diathermic frequencies, but that the rapidly changing field causes the production of local currents in the tissues which, in the manner of the production of Eddy or Foucault current, are locally dissipated into heat.

This is made plausible by the well-known fact that the flow of electrical current in a composite medium is concentrated in the medium having the highest conductance, and that it distributes over the largest volume offered by the conducting substance. Short wave fields, however, traverse most substances more uniformly, but react, in respect to heat production, differently by producing under certain conditions, more heat in a better conducting substance than in one having a higher electrical resistance. Therefore, a high resistance medium in series with a better conducting substance might not cause any great loss of energy, but rather, a concentration of energy dissipation in the substance having the lower electrical resistance.

Under some conditions, therefore, an air space or a very high dielectric between the electrodes and the patient would be permissible or even required, and it would seem that one of the principal advantageous features of short wave therapy is the possibility of confining the heat dissipation of electrical energy upon one given substance by placing in series with it

media having a lesser dissipating power for electrical energy than the substance to be heated.

The earliest summary of experiments on electrical high frequency fields of between 3 to 12 meters wave length applied to plants and animals seems to be that of Georges Lakhovsky (4). The plants were placed, without using electrodes, in the field of an inductance winding. J. W. Schereschewsky (5) placed small animals in a box-like arrangement of which two sides comprise the plates of a condenser, thus subjecting the animals to the oscillating field between the plates. A. Esau (6) and E. Schliephake (7) showed the use of spaced electrodes without making contact and H. R. Hosmer (8) described the heating effect of high frequency fields with cold electrodes spaced by air gaps from the object to be heated.

Therefore, the air space between electrodes and the parts to be treated appear to be an important condition to the possibility of utilizing the action and the effects that are specific of the ultra-short wave lengths. But in spite of these apparently distinctive properties of short wave frequencies and a lack of evidence that the particular frequencies alone are responsible for specific or selective effects (7), the short wave currents are extensively applied in clinical practice with the same types of electrodes and in the same manner as the older diathermic currents and electrodes. Electrodes are manufactured and sold, and instructions for their use are given with them which are not apparently in conformity with the specific electrical requirements and thereby practically all the advantages of short wave over ordinary diathermic therapy are lost. A series of experiments described in the following are intended to elucidate some of the principles and the results obtainable under various conditions of application of short wave currents.

Experimental—The short wave generator employed for these experiments is a Hartley Circuit, and the oscillating condenser is developed so that the object to be

the outlet, a temperature of 112 degrees was recorded with, therefore, a loss of three degrees in the heating unit attached to the patient

EXPERIMENTAL ERYTHEMA

The establishment of biological proof is difficult, so, therefore, the interpretation of our results must depend, in the main, upon clinical observation

Though our experience is not as yet sufficient to warrant us in drawing definite conclusions, our experiments would indicate that very little dosage is required to produce a given radiation effect when treatments are applied through the heater at the temperature above indicated. In other words, when heat is simultaneously employed, a so-called skin erythema dose can be administered in considerably less time or with less intensity of radiation. We found that from one-third to one-half the quantity of radiation administered through the heater is sufficient to produce a reaction similar to that resulting from a full unit erythema dose directly applied without heat with a similar quality of radiation.²

THE TREATMENT OF SUPERFICIAL LESIONS

Using the foregoing as a guide for procedure, we treated certain selected cases of superficial epithelioma with the dosage one-half of that routinely used by us in the continuous massive method of application.³ This method of treatment was chosen in preference to the cumulative, since we felt that we had the greatest experience along these lines. Only those cases in which the closest coaptation of the heating unit was possible were suitable for this type of treatment

² The skin erythema dose as applied in our department with unfiltered rays at 130 kilovolts is equivalent to 350 r continuous radiation with an output of 70 r per minute at a 40 cm skin focus distance. The quality of radiation is represented by a half value intensity of 1.75 mm of aluminum (measured by ionization)

³ In our massive dose method we applied on an average of ten erythema doses continuous radiation at 140 r per minute to areas from one half to three-quarters of an inch in diameter, at 29 cm skin focus distance

Our first six cases so treated would indicate that, with this curtailed dosage with the heater, the end-results were as satisfactory as in those cases in which the more massive dosage was applied. The differences observed were that there was less local reaction and little or no tendency to ulceration with scab formation, the lesions, therefore, regressed and disappeared with but little of the inflammatory reaction previously observed

THE POSSIBILITY OF HEATING DEEPER TISSUES AS A SENSITIZING AGENT IN DEEP RADIATION THERAPY

The problem of applying heat to deeper-lying tissues (and lesions) is far more difficult than the method of surface application as above described. The comparatively recent introduction of short wave therapy appears to offer a solution to the problem. However, with respect to the method of application as well as to the question of heat concentration, there are uncertainties which require clarification. It, therefore, becomes necessary to conduct a series of experiments which short wave therapy before this method can be logically combined with radiation therapy

The more important questions under consideration are the following

- 1 What is the most suitable method of applying electrodes?
- 2 Under what conditions can the greatest degree of heat concentration in the deeper structures be obtained with minimal effect on the surface?
- 3 What is the influence of short wave therapy on different types of structure, such as water and fatty substances, in different positions with relation to the electrodes?
- 4 What arrangement forms the most suitable method of combining short wave therapy and radiation therapy?

EXPERIMENTS IN SHORT WAVE THERAPY

Diathermic currents, of frequencies between 500,000 and 2,000,000 cycles per

TABLE II

Thermometer	1	2	3	4	5	6	7
Temp at start	21 0	21 3	21 0	21 2	21 2	21 0	21 3
Temp after 20 min run	26 9	28 0	28 6	29 6	28 9	27 5	27 6
Diff of temp	5 9	6 7	7 6	8 4	7 7	6 5	6 3
Thermometers crosswise		28 7	29 3	29 5	28 5	26 0	
Diff of temp		7 4	8 3	8 3	7 3	5 0	

TABLE III

Thermometer	1	2	3	4	5	6	7
Temp at start	22 9	23 3	23 0	23 0	22 8	23 0	23 3
Temp after 20 min run	28 0	28 8	29 4	29 0	29 4	28 8	28 0
Diff of temp	5 1	5 5	6 4	6 0	6 6	5 8	4 7

The temperature increment in the center portion of the jelly after a 20 minute run is greater than in Experiment I. Melting of gelatine at the ends started only from the fifteenth minute on. The wooden sides of the box through which the field was applied were quite warm and evidently caused the melting of the gelatine, the long sides had remained cold.

Thermometers placed transversely showed also a slight temperature increase in the center as against that at the borders.

It is to be concluded that the absence of padding (or the presence of the air gap) has a distinctly advantageous effect upon the utilization of the short wave energy absorbed in a medium to be treated, in that then, instead of being largely consumed in heating of dielectric padding, the energy is consumed to a considerably greater extent in the middle part of the jelly.

III. A still further variation from the experimental conditions of Experiment I was introduced by removing the wooden trough from around the jelly block and suspending freely the bare metal electrodes in air, thus there was then no dielectric except air between the electrodes and the jelly block.

The total temperature increase as the result of the 20-minute application of the

output of the short wave generator is again slightly less, but in this experiment the maximum in the center is distinctly higher over the temperature rise of the borders and near the electrodes than it was in the previous experimental runs.

It is to be concluded from these experiments that the production of a maximum of heating in the center of a medium without also over-heating the sides through which the energy is applied, is only possible if dry air (or extremely high dielectrics) is present between the electrodes and the medium to be treated.

IV. An arrangement of the media through which the short wave length field was caused to pass, quite different from the preceding arrangements, was made for the following experiment.

In series with the gelatine jelly was placed a block of lard, as shown in Figure 2. Otherwise, the electrodes were placed with air gaps as described in Experiment III. The combined block of gelatine and lard, therefore, represents that part, of the patient to be treated, consisting of several substances, as, for example muscle layers or bone and fat, and so placed with respect to the electrodes that the field first passes through one medium and then through the other.

TABLE IV

Thermometer	1	2	3	4	5	6	7
Temp at start	13 0	12 0	12 0	12 5	14 8	16 2	17 0
Temp after 20 min run	17 0	17 0	16 0	16 5	21 9	24 0	25 0
Diff of temp	5 0	5 0	4 0	4 0	7 1	7 8	8 0
← Gelatin →				← Lard →			

treated can be placed between the condenser electrodes. The entire oscillating unit is housed in a metal cabinet, and a balancing condenser, variable from the outside, is employed to balance the circuit to resonance. This condition is then indicated by a coupled circuit containing a current meter which, by maximum reading, indicates the condition of balance.

Other devices employed are a number of Hg-in-glass chemical thermometers which were previously compared in a water bath at various temperatures. A block of gela-

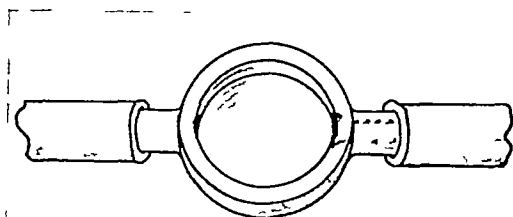


Fig 1 Contact water heater for direct application of heating (For a detailed description, see text)

tine was prepared by dissolving 230 g of cooking gelatine in 3,800 ml of hot water, pouring it into a wooden trough and allowing it to stand at room temperature. The result is then a stiff jelly, and for measuring its temperature the thermometers can be easily pushed into the mass of the jelly in evenly spaced places, during the treatment the thermometers were removed. For some of the experiments, in order to enable the block to be removed from the trough, the jelly block is removed from the wooden trough by immersing the latter in hot water which causes a small quantity of gelatine near the sides to become liquid. Another medium employed is lard, which at ordinary temperature is sufficiently consistent to exhibit the same plastic properties as the jelly.

I The experimental arrangement is shown diagrammatically in Figure 1. This

arrangement corresponds generally to the conditions under which short wave therapy is clinically applied, and a number of manufacturers give directions that it be applied in this manner. Metal foil electrodes, either covered with an insulating substance or bare, are usually spaced from the patient's skin with felt, towels of other substances are assumed to have high dielectric properties.

The thermometers were evenly spaced and pushed down to the middle of the mass of the jelly, they were read before and after the application of the current but were removed during the application. After the full output of the machine had been applied for 20 minutes, there was a slightly higher elevation of temperature in the middle portion of the jelly, but from about the tenth minute on, there was profuse melting of gelatine at the sides at which the electrodes and the padding were applied. The padding also, especially if it was of starched towels, had heated very strongly.

The conclusions from this test are that if the electrodes are spaced from the medium to be treated with dielectric substances, such as felt, towels, wood, etc., then these substances dissipate and absorb a large portion of the applied electrical energy. The heating is strongest in the better conducting substances, such as wet wood and starched towels, and least in a perfectly dry felt padding. However, in a general way the appearance of the results of this method of application differs in no essential respect from that observed from the application of ordinary diathermic currents.

II The same experimental run was made except for leaving out the padding and suspending the electrodes so that instead of the padding there was an air space between the gelatine contained in the box and the electrodes.

TABLE I

Thermometer	1	2	3	4	5	6	7
Tempt. at start	20 0	19 9	19 5	19 8	19 6	20 0	20 0
Tempt. after 20 min run	29 0	29 6	30 0	31 0	30 0	29 2	29 3
Diff temp °C	9 0	8 7	10 0	10 2	10 4	9 2	9 3

This deduction is in full agreement with the laws of field distribution in and around dielectrics (9). Therefore, it follows from

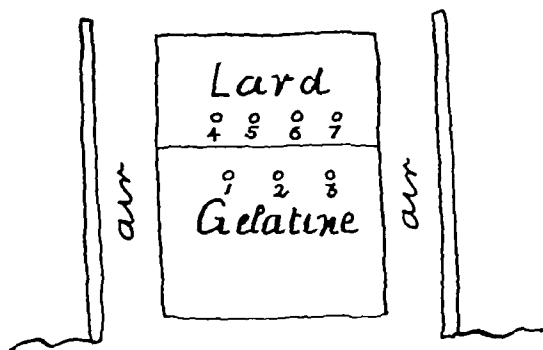


Fig. 4 Short wave experiment with fat and gelatine in parallel with the electrodes. In this experiment the lard and gelatin blocks were placed at right-angles to the position indicated in Figure 3. The position of the electrodes with intervening air spaces is as before. This arrangement of the thermometers is again indicated.

this experiment that the distribution of the heating in unlike substances is entirely different in the two cases of parallel or series traversing of different substances by short wave length fields.

DISCUSSION

Quite evidently, when contact is made between the electrodes and the medium to be treated, the current is conducted through the medium and the distribution of the lines of force in substances having different resistances is in accord with Ohm's law and heating is produced according to Joule's law, $i^2 R$, dependent on RI^2 .

Short wave length fields, if applied through air spaces between the electrodes and the medium to be treated, distribute according to the permeability of the inter-placed media. If the medium is homogeneous in composition, the maximum temperature rise is in the center of the medium, and the air space, in the case of living patients, may contribute materially to this effect, due to surface cooling caused by the circulation of air.

In a heterogeneous medium, if two different media are placed parallel to the direction of the field, there is a distortion of the field and a more intensive concentration of

it in the more permeable substance. If the two media are placed one above the other or in series grouping to the direction of the field, then the same field must pass through both media. A differential heating may take place, depending on the reaction of the medium to the field and on its specific heat.

It appears particularly indicated that attention be directed to those facts insofar as they pertain to the clinical treatment of patients having layers of adipose tissues located over layers of muscle tissue or bone. If the field is passing first through fat and then through muscle tissue, then there is likely to be more intensive heating in the fat, and it appears that a high temperature in muscle tissue cannot be produced without also developing a considerably higher temperature in the fatty layers.

But in the parallel arrangement of the media to the field, the fat layers are protected against overheating to the extent that any desired high temperature may be produced in the muscle layers without appreciably heating or injuring the fat layers.

SUMMARY

The experiments reported herein indicate that—

(1) The conductive contact of a dielectric substance between the electrodes and the patient gives rise to surface heating as well as heating of the dielectric. It also prevents a free circulating air space and surface evaporation.

(2) The most advantageous utilization of the characteristics of short wave therapy is accomplished when the electrodes are separated from the patient by an air space.

(3) With homogeneous parts to be treated, the maximum heating is in the middle of the part.

(4) With heterogeneous parts, if the parts are in series to the direction of the field, there is heating in all these parts but more in those having a lesser permeability, if the parts are in parallel to the direction of the field, there is greater heating in the part of greater permeability for the field.

(5) For patients' parts which are cov-

There are notably different temperature increases in the two substances, but the difference might be due to the lower specific heat of lard, as the result of which the same number of calories of heat generated in lard as in gelatine would produce a greater temperature rise in the lard. Again, it might be just simply due to a different rate of dissipation of short wave energy which causes the different heating in the two substances. The conditions are too

muscle or bone, then there will be heating in this fat layer to a distinctly greater extent than in the muscle layers

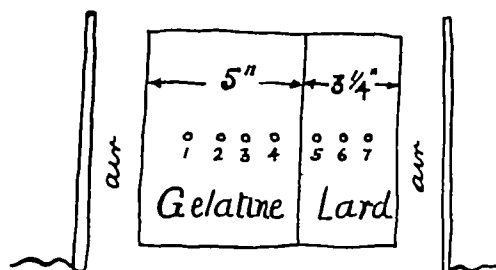


Fig 3 Short wave experiment with lard and gelatine in series. The use and arrangement of blocks of lard and gelatine and also the position of the electrodes separated by an air space from the block are shown. The numbers from one to seven indicate the position of the thermometers with the size of the respective blocks in inches as marked.

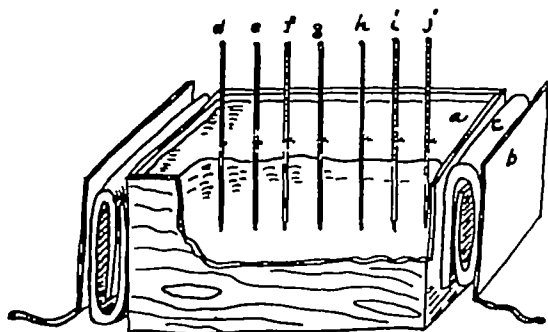


Fig 2 The conditions of the first experiment with short wave therapy. The sketch illustrates a wooden box with part of the front broken away so as to reveal the gelatine contents with the thermometers in place. The electrodes are illustrated at the ends of the box with intervening padding (a) gelatine in box, (b) electrodes, (c) padding (d) to (j) thermometers.

complex to make a definite explanation possible.

Notably absent in these results is the greater extent of heating in the central regions. The reason for this is that a separation of the lard from the gelatine took place during the run and this caused some loss of heat and cooling in the center portion of the block. But heating resulted in both media as is to be expected on the basis that the field passes first through one medium and then through the other.

It is, therefore, shown by this experiment that if a fat layer is to be traversed by a short wave field that is in series with either

V In the arrangement shown in Figure 2, the gelatine and lard block was turned around so that the field traversed the two substances in parallel arrangement. The electrodes, which are air-spaced from the blocks, covered the end-ports of the two substances and, therefore, the same field was applied to both the gelatine and the lard block. Some of the thermometers were placed in the gelatine and some in the lard, as shown in Figure 3.

Striking is the fact, of course, that practically no heating took place in the lard. This is an indication that either the short wave length field is not absorbed appreciably in the lard or that the field was conducted very much better in the gelatine than in the lard. But Experiment IV shows that, if the short wave field is forced to pass through a substance such as lard, that heating takes place in it. Hence, in this experiment, the field, since no heating took place in the lard, must have been displaced and conducted better in the gelatine than in the lard.

TABLE V

Thermometer	1	2	3	4	5	6	7
Temp at start	15.8	16.3	16.2	18.6	20.2	21.0	21.3
Temp after 20 min run	26.0	32.0	28.2	19.2	20.3	21.0	21.5
Diff of temp	10.2	15.7	12.0	0.6	0.1	0.0	0.2
	← Gelatine →			← Lard →			

THE END-RESULTS OF INJURIES TO THE EPIPHYSES¹

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THE purpose of this paper is to present the end-results in a group of traumatically displaced epiphyses. The work was prompted in answer to the oft-repeated question, "Does premature ossification or deformity result from such an injury?" Follow-up studies by means of roentgen examination were made from sixteen months to eight years after the injury.

A review of the literature reveals relatively few articles which concern themselves with end-results subsequent to epiphyseal trauma. The conclusions of these papers are not in agreement. Eliason and Ferguson (1) have reported a series of 110 cases involving the epiphyses of various long bones of the body, from which they conclude that premature ossification occurs infrequently and that the degree of reduction is not a factor. Aitkin (2) has reported on 60 cases of displaced distal radial epiphyses and concludes that premature ossification with disturbance in growth occurs frequently but is usually insufficient to be of clinical importance. Compere (3) has reported a series of 19 cases in which the frequency of disturbed growth was 95 per cent, in a very high percentage this change in growth was of clinical significance.

The epiphysis is a secondary center of ossification the purpose of which is to promote bone growth. Its blood supply is practically independent of the shaft and is obtained from the periosteum. Only one or two small vessels pass from the shaft through the epiphyseal cartilage into the epiphysis. Ossification in the epiphyses and their union with the shaft occurs in a certain sequence. Those epiphyses which bear the largest relative proportion to the

shafts to which they belong ossify first. Union with the shaft takes place first in those epiphyses toward which the nutrient vessel is directed. The epiphysis which is the last to appear is the first to unite. Growth takes place faster and for a longer period of time at the epiphysis which unites last. Since the nutrient vessels are directed toward the elbow and away from the knee, it is well known that growth takes place more rapidly about the knee, shoulder, and wrist. If injuries to the epiphyseal regions result in growth disturbances, then injuries to these areas should result in the more marked growth disturbances.

In this series of cases which we studied, re-examination of the injured as well as the uninjured member was made when possible. Roentgenograms of the limb in its entirety were made so that measurements of length could be accomplished and observations of deformity and premature ossification could be noted. The long bones of 33 presumably normal juveniles were examined and used as a basis of normal variation in bone length of one side of the body to the other. In this group of normals, we noted that in the radius there was a maximum variation of five millimeters. Most of the radii were either the same length or varied from one to two millimeters. These same variations held true for the ulna, tibia, and fibula. In the humerus there was a slightly greater normal variation. The difference in length amounted to as much as nine millimeters, with most of the humeri varying four millimeters.

In our files in the x-ray department from 1927 through 1933, we have records of 380 cases of traumatically displaced epiphyses (Table I). The epiphysis of the lower end of the radius was most frequently involved and accounts for 234, or practically three-fifths

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ered with fat layers, bones, or fluids and gases embedded in tissues, *i e*, whenever a distinct heterogeneity in regard to permeability to short wave field exists, in the series order of arrangement there is danger of overheating the less penetrable parts in relation to the heating produced in the more readily penetrated portions

(6) In the treatment of deep-seated lesions by the combined short wave heating and radiation therapy method, the indicated procedure as applied by us is that the direction of roentgen irradiation would best be applied at right-angles to the field of short wave application, the electrodes being separated by an air space from the patient, with free air circulation and no interposition of insulating material. The

time of application of short wave therapy should immediately precede and preferably continue through the time of roentgen exposure

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two months later revealed premature ossification, with a shortening of the humerus of 25 millimeters. In one case in which the

epicondyle constitute the group of follow-up studies of epiphyseal injuries about the elbow. In two of these cases, one of each

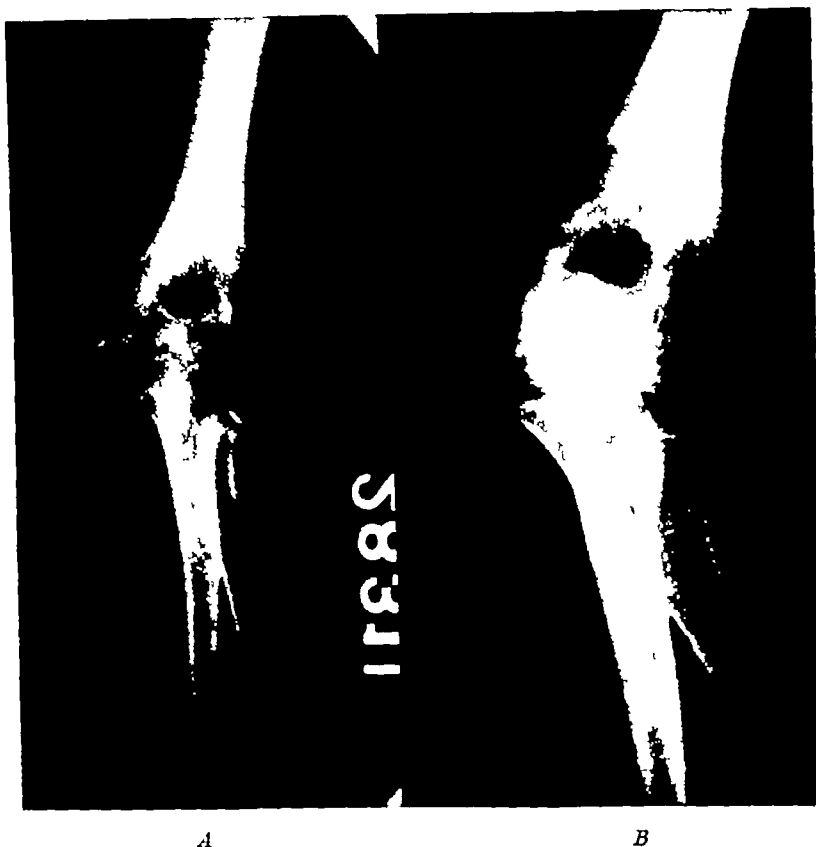


Fig 2 Patient is a girl, aged 11 years. Date of injury, May 2, 1929. A, Separation of the epiphysis of the medial epicondyle, with fracture of the neck of the radius. Elbow was immobilized with the alignment remaining the same. B, Roentgen study made Sept 4, 1934. There is non union of the epiphysis of the medial epicondyle and a deformity of the upper end of the radius.

offset was quite minimal, a follow-up study made twenty months later revealed premature ossification, with a shortening of the humerus of 16 millimeters. In both these cases of altered growth the cartilage on either side was very thin, so that it is very unlikely that there will be any appreciable further change when growth is completed. In the other three cases there was no interference with growth. Only one of these five cases was examined at the time of complete fusion of the epiphysis with the shaft.

Five cases of separation of the epiphysis of the medial epicondyle and one case of separation of the epiphysis for the lateral

type, there was an associated dislocation at the elbow. Three of the separated epiphyses for the medial epicondyle underwent non-union (Fig 2), while the other three epiphyses united. This group of injuries occurred in individuals from seven to sixteen years of age. Five of these cases were observed at the time of completed growth about the elbow.

Only one case of separation of the epiphysis of the lesser trochanter was re-examined. This injury occurred in a 14-year-old boy in whom reduction of the separation could not be accomplished. Re-examination five years later revealed that the epiphysis had united, leaving a very

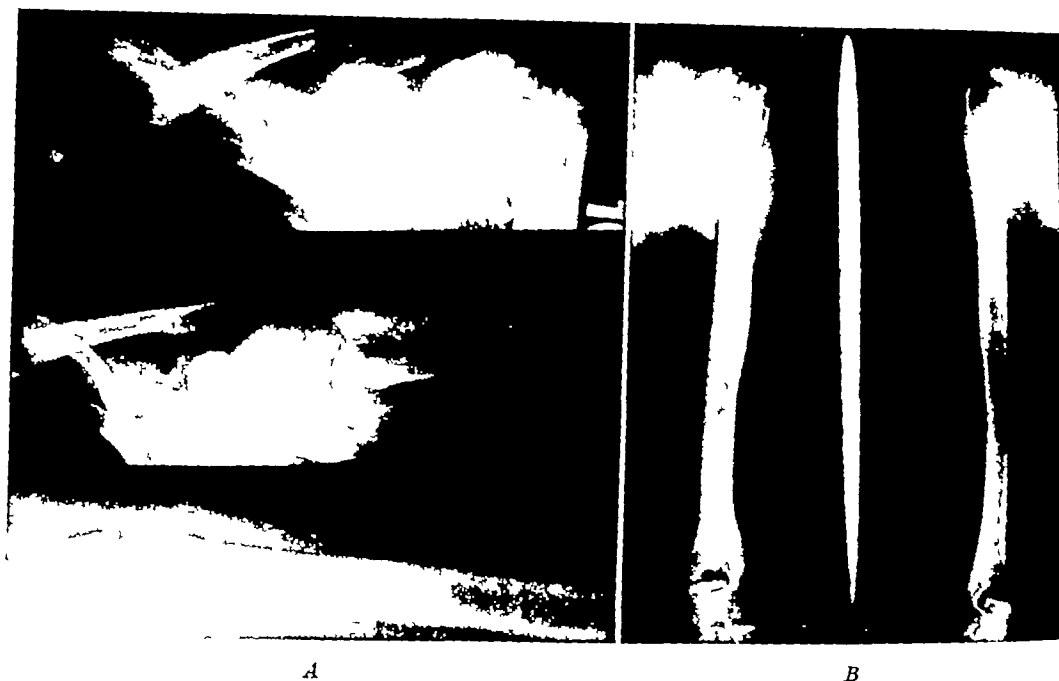


Fig 1 Patient is a boy, aged 12 years Date of injury July 28, 1933 *A* Upper study is the first examination, middle study, the anteroposterior view after reduction lower view the lateral view after reduction *B* Injured side on the left examined May 2 1935 There is advanced ossification with resulting shortening of the shaft of 25 mm The uninjured side is on the right

of all the cases The lower epiphysis for the tibia was next in frequency and accounts for 59 of the cases The upper

Follow-up studies from sixteen months to eight years later were possible in 106 cases, occurring in 100 individuals (Table

TABLE I—DISTRIBUTION OF CASES OF TRAUMA TO EPIPHYSES FROM 1927 TO 1933

Epiphysis of lower end of radius	234
Epiphysis of lower end of ulna	15
Epiphysis of lower end of tibia	59
Epiphysis of lower end of fibula	4
Epiphysis of medial epicondyle of humerus	36
Epiphysis of lateral epicondyle of humerus	7
Epiphysis of upper end of humerus	18
Epiphysis of lesser trochanter of femur	4
Epiphysis of lower end of femur	3

380

TABLE II—DISTRIBUTION OF CASES WHICH WERE RE-EXAMINED

Epiphysis of lower end of radius	71
Epiphysis of lower end of ulna	5
Epiphysis of lower end of tibia	16
Epiphysis of lower end of fibula	2
Epiphysis of medial epicondyle	5
Epiphysis of lateral epicondyle	1
Epiphysis of upper end of humerus	5
Epiphysis of lesser trochanter of femur	1

106

epiphysis of the femur was not included in this series because of the difficulty in establishing trauma as the sole factor Separation of the epiphyses of such long bones as the metacarpals or flat bones, such as the phalanges, were also excluded in this study It will be noted that separation of some of the epiphyses about the elbow, such as the capitellum and trochlea of the humerus, the epiphysis for the head of the radius, and the epiphysis of the olecranon process of the ulna, did not occur in our series

II) In five of these cases there was a separation of the proximal epiphysis of the humerus in individuals between the ages of eleven and fifteen In four of them there was an associated fracture of the adjoining diaphysis In three of these four cases the degree of offset was not great enough to warrant reduction, while in the fourth case, there was a considerable offset which could not be completely reduced The final study after reduction revealed a lateral displacement of the shaft through about one-half its width, with some over-riding (Fig 1) The study made twenty-

was from seven to sixteen millimeters shorter than the uninjured, the ulna, as a consequence of this disturbed growth, be-

In all the cases involving the lower end of the radius, reduction of the displaced epiphysis was attempted and usually ac-



Fig 4 Patient is a boy, aged 15 years. *A* (upper left) Lateral and anteroposterior views at first examination, May 27, 1932. Marked displacement of distal epiphysis of radius, with fracture of shaft. *B* (lower left) Study made after reduction. *C* Forearm on left, injured side (May 31, 1935). Note advanced ossification in radius, which has become 16 mm shorter than the normal one on the right. There is a resulting relative increase in the length of the ulna on the injured side as compared to the uninjured side.

came relatively longer on the injured than on the uninjured side. In none of these cases, however, was there enough disturbance in growth to permit the styloid process of the ulna to become as long or longer than that of the radius. In only two cases was there evidence of slightly greater ossification of the epiphysis, both of these occurred in individuals in whom the injured radius measured eight and sixteen millimeters shorter than the uninjured (Fig 4). In the former case, growth was almost completed, whereas in the latter case growth was practically at an end. Only eleven of the 36 fractured ulnar styloids united.

compulsed in the first effort. In one instance a boy of thirteen came to the outpatient department two weeks after he had fallen off a parallel bar and injured his wrist (Fig 5). He was sent to the x-ray department for study and was asked to return to the clinic on the following day. The x-ray examination revealed a posterior displacement of the distal epiphysis of the radius through one-half its depth, with tilting of the articular surface. Through some misunderstanding, the boy returned to the wrong clinic and, when an effort to rectify this mistake was made, he misunderstood these good intentions and finally gave up his original thought of

definite deformity because of the excess bone production needed to fill in the area of separation (Fig 3)

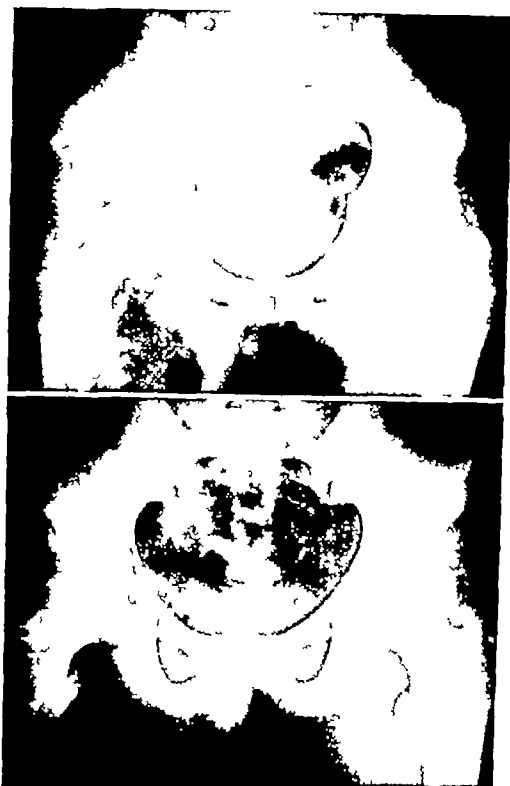


Fig 3 Patient is a boy, aged 14 years Date of injury, March 20, 1929 re-examination Dec 27, 1934 The upper figure reveals the separation of the epiphysis of the lesser trochanter on the left side Reduction not possible. Lower figure reveals a resulting deformity five years later

In injuries about the ankle, separation of the distal epiphysis of the tibia accounted for 16 of the re-examined cases They occurred in a group of individuals ten to sixteen years of age In all but two there was an associated fracture through the adjoining shaft, in four of the cases there was an associated fracture of the distal third of the shaft of the fibula In two of these cases, there was a fracture through the epiphysis, with separation of only that portion of the epiphysis involved in the fracture In one instance there was a slight separation of the distal epiphysis of the fibula There was no interference with growth in any of these cases In this group of ankle injuries there was also one

case of separation of the distal fibular epiphysis, with minimal fracture of the adjoining shaft but with no other bony injuries about the ankle Final film study in this instance revealed no evidence of disturbed growth Five of this entire group of 18 epiphyseal separations were re-examined after complete fusion of the epiphysis with the shaft

Re-examinations were made in 71 cases of displaced epiphysis which involved the lower end of the radius (Table III), in

TABLE III—FINDINGS IN DISPLACEMENT OF DISTAL RADIAL EPIPHYSIS

Number of cases	71
Age of patients (years)	7-17
Number with fracture of shaft	56
Number with fracture of ulnar styloid	36
Number of cases with fracture of shaft of ulna	4
Number of cases with disturbance in growth	6
Number in which ulnar styloid did not unite	25
Number followed to complete ossification	17
Number with separation of epiphysis of ulna	3

individuals who ranged from seven to seventeen years of age In 56 of these cases, there was an associated fracture of the adjoining diaphysis In 36 cases there was a fracture of the styloid process of the ulna, in four others, an associated fracture of the distal third of the shaft of the ulna In three of these cases, there was a separation of the distal epiphysis of the ulna Seventeen of these cases were observed at the time of completed growth Roentgenographic evidence of growth change was noted in six instances, but none of them was of clinical significance (Table IV) In these six cases, the injured radius

TABLE IV—DISTRIBUTION RADIAL CASES WITH SHORTENING OF THE SHAFT

Age	Time Followed	Milli-meters Shorter	Degree of Ossification
9	36 months	14	Normal
11	20	7	Normal
12	28	7	Normal
13	34	7	Advanced
15	24	15	Complete
15	36	16	Advanced

DISTRIBUTION OF ULNAR CASES WITH SHORTENING OF THE SHAFT

14	20 months	9	Advanced
15	65	14	Advanced
14	38	29	Advanced

was from seven to sixteen millimeters shorter than the uninjured, the ulna, as a consequence of this disturbed growth, be-

In all the cases involving the lower end of the radius, reduction of the displaced epiphysis was attempted and usually ac-



Fig 4 Patient is a boy, aged 15 years *A* (upper left) Lateral and anteroposterior views at first examination, May 27, 1932. Marked displacement of distal epiphysis of radius with fracture of shaft. *B* (lower left) Study made after reduction. *C* Forearm on left, injured side (May 31, 1935). Note advanced ossification in radius, which has become 16 mm shorter than the normal one on the right. There is a resulting relative increase in the length of the ulna on the injured side as compared to the uninjured side.

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undergoing treatment. He carried his arm in a sling until it felt better and then began to use it. Follow-up study made twenty-

the left side had slipped to a slightly lesser degree. No further treatment was attempted. Films made sixty-five months



Fig 5. Patient is a boy aged 13 years. Injury occurred two weeks before the first study was made Nov 2, 1932. *A*, First examination. Note the marked displacement of the epiphysis of the radius, also the periosteal new bone along the posterior margin of the shaft. There is likewise a fracture of the styloid process of the ulna. No treatment was received in this case. *B*, Roentgen study made Nov 5, 1934. Injured side on the right—normal growth. Uninjured side on the left.

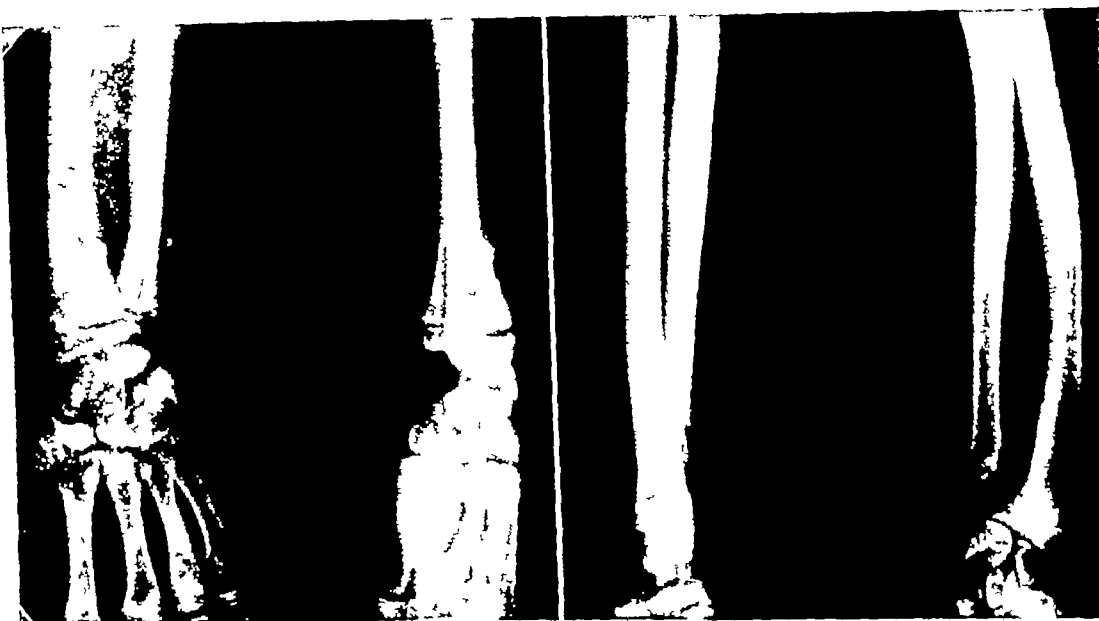
four months later reveals no abnormality whatever about the injured radius, and it looked no different from the uninjured one. A somewhat similar experience as to what is considered inadequate treatment was encountered in the case of a seven-year-old boy who fell and sustained displacement of both distal radial epiphyses, which were subsequently replaced and immobilized. Film study made after the removal of the plaster thirty days later revealed that the epiphyses had slipped so that the one on the right was displaced posteriorly through slightly more than one-third the depth of the epiphysis, while the one on

later reveal no evidence of any growth disturbance.

In our series, we gathered five cases of separation of the distal epiphysis of the ulna. Three of these were in association with displacement of the distal epiphysis of the radius, the other two were in association with green-stick fractures of the distal third of the shaft of the radius. In three of these cases the epiphysis was displaced and carried with it a fractured fragment of the adjoining diaphysis, while the other two cases were characterized by fractures through the styloid process of the ulna which continued through the epiphysis

and the adjoining postero-lateral portion of the adjoining diaphysis. Reduction was accomplished in all of these cases

It will be noted that in arrested growth of the ulna there is a resulting ulnar bowing of the radius which is proportional to



A

B

Fig 6 Patient is a boy, aged 13 years. Date of injury Jan 24, 1932. A, Anteroposterior and lateral views showing greenstick fracture of radius and fracture through the styloid process of the ulna, with fracture through the epiphysis and the postero-lateral margin of the adjoining shaft. There was no improvement on reduction. B, Re-examination on March 22, 1935. Roentgen study reveals a premature ossification of the lower end of the ulna, with a resulting shortening of the shaft of 29 millimeters. Note the ulnar bowing of the radius as a consequence.

except for the one in each group mentioned. In three of this small group of five cases there was a resulting premature ossification of the epiphysis, with resulting shortening of these ulnæ (Table IV). Two of these were in the first group mentioned in which the entire epiphysis was displaced, the third one occurred in the other group in the case in which reduction of the fracture was not accomplished (Fig 6). In addition to the suppressed growth of these ulnæ, there was also an ulnar bowing of the radius, which was in proportion to the degree of shortening of the ulna. The resulting shortening ranged from nine to twenty-nine millimeters. These cases occurred in boys ranging from thirteen to fifteen years of age. Only two of these cases were observed at the time of completed growth, while in the others growth was almost complete.

the degree of suppressed growth in the ulna and, with this, there is an ulnar deviation of the wrist. If the deviation is not marked, this does not become of any clinical consequence, because the hand is normally strongest with the wrist in a state of ulnar deviation—the position assumed in heavy lifting or gripping. This tendency toward ulnar deviation of the radius in altered ulnar growth is best explained by assuming that, since in the use of the hand maximum strength is obtained with the wrist in a state of ulnar deviation, the tendency of ulnar bowing of the radius is normally present, but because of the splinting effect of the ulna this cannot take place during growth. In suppressed growth of the ulna during development this natural splint is removed and an ulnar bowing of the radius results. In arrested growth of the radius we have not

encountered in our work or noted elsewhere any radial bowing of the ulna. It would appear from the normal anatomy of the wrist that a certain amount of relative overgrowth of the ulna can be taken up by the soft tissue structures present between the lower end of the ulna and the triquetral bone. Until this space is taken by the relatively lengthened ulna there is no pressure on the triquetral to create a radial deviation of the wrist. When this does happen, radial deviation of the wrist supervenes but radial bowing of the ulna apparently does not take place because the wrist is then in a condition in which use of the hand is normally at its weakest—apparently not enough physical force can be mustered during development to cause radial bowing of the ulna even in the presence of an abnormally shortened radius.

SUMMARY

One hundred and six traumatically displaced epiphyses were observed for a period of time ranging from sixteen months to eight years following injury. Only a small percentage of these cases were seen less than two years later. This time interval is considered sufficiently long for growth disturbances to manifest themselves if they are to take place at all. In 15 cases there was x-ray evidence of premature ossification and suppression of growth (Table V).

ing from eight to sixteen millimeters, three cases in which the epiphysis for the medial epicondyle of the humerus failed to unite after separation, three cases in which there was premature ossification with shortening of the ulna, two cases which involved the proximal epiphysis of the humerus in a similar manner, and one case in which the separated epiphysis for the lesser trochanter of the femur united with deformity. In only three of these many re-examined cases was there noted a slight disturbance in function—cases of separation of the epiphysis of the medial epicondyle of the humerus which underwent non-union and resulted in a very slight limitation of extension. In all the other cases there was no limitation of motion.

CONCLUSIONS

1. Premature ossification, with changes in growth, takes place frequently after epiphyseal injury. It occurred in 15 cases in this series of 106 cases, or an incidence of 14 per cent.

2. The amount of shortening, however, is usually minimal and not of clinical significance.

3. Occasionally, however, we have a case in which the disturbance in growth is marked, resulting in deformity and disturbance in function. This occurs whether or not perfect reduction is obtained and

TABLE V — DISTRIBUTION OF THE 15 CASES OF SUPPRESSED GROWTH OR DEFORMITY

Epiphysis Involved		Resulting Abnormality
1	Upper humerus	Premature ossification and 16 mm shortening
2	Upper humerus	Premature ossification and 25 mm shortening
3	Medial epicondyle humerus	Non union
4		
5		
6	Lower radius	7 mm shortening
7		7 mm shortening
8		8 mm shortening with advanced ossification
9		14 mm shortening with advanced ossification
10		15 mm shortening
11	"	16 mm shortening with advanced ossification
12	Lower ulna	9 mm shortening with advanced ossification and of radius bowing
13		14 mm shortening with advanced ossification and of radius bowing
14	" "	29 mm shortening with advanced ossification and of radius bowing
15	Lesser trochanter of femur	Deformity

This group is made up of six radial cases in which there was retarded growth ranging from eight to sixteen millimeters, three cases in which the epiphysis for the medial epicondyle of the humerus failed to unite after separation, three cases in which there was premature ossification with shortening of the ulna, two cases which involved the proximal epiphysis of the humerus in a similar manner, and one case in which the separated epiphysis for the lesser trochanter of the femur united with deformity. In only three of these many re-examined cases was there noted a slight disturbance in function—cases of separation of the epiphysis of the medial epicondyle of the humerus which underwent non-union and resulted in a very slight limitation of extension. In all the other cases there was no limitation of motion.

4 Perfect reduction should be attempted, but may not be necessary in the treatment of the traumatically displaced epiphysis

5 Osteotomy in neglected cases in the young is probably not necessary, since the deformity does not persist

6 In disturbed ulnar growth, ulnar bowing of the radius supervenes and, if very pronounced, produces disturbed function

7 In disturbed radial growth, radial bowing of the ulna does not result. Disturbed function results only from the more marked growth disturbances

The author wishes to thank Dr K E Fritzell, of the surgical staff, for his help

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DISCUSSION

DR LEO G RIGLER (*Minneapolis*)
Anyone who has practised roentgen diagnosis for a long period of time has either been asked or has asked himself the question over and over again, when he sees these cases of displaced epiphyses, as to what the end-results will be

I think there has been in the back of our minds, at least, a considerable fear in every case in which we see a rather marked displacement of the epiphysis that a serious deformity may result because of the disturbance in growth which ought to occur. One would think it ought to occur.

If you consult textbooks for this answer, I think you will find that they uniformly evade it and that there is little or nothing to give you an intelligent concept of the end-result. It is for this reason that Dr Lipschultz entered into this study in the

hope of being able to give a more adequate answer than had previously been given.

I think, on the whole, the results of his work would indicate that no great fear should be felt—that the end-results of traumatic injury to the epiphysis are not very serious in the vast majority of cases.

Incidentally, he finds that the degree of reduction apparently is not an important factor, and I should like to emphasize again the one case he showed in which no reduction was attempted, in which perfect results occurred. There have been other cases of similar nature reported in the literature.

I might say parenthetically that because of lack of time, he did not show all the films on these cases. The question might arise, for example, as to what the lateral view showed in that particular case he demonstrated, and I can assure you that there was no deformity whatsoever visible in the lateral as well as in the anteroposterior view.

I think, however, we should not be misled by this result into thinking that infectious lesions at the epiphyseal line, or other types of non-traumatic injury, would have the same result. Many years ago Huenekeens and I reported a case of osteomyelitis variolosa the osteomyelitis of smallpox, in which multiple abscesses occurred in the epiphyseal zone itself. This was in a child, a most extreme and serious deformity resulted because of the fact that growth was promptly stopped after a few months, —and because, again, only one bone of the forearm or of the leg was involved, a marked deviation of the extremity occurred, with a marked disturbance of function.

Similarly, the late Harry Hillstrom in our department studied the effects of irradiation on the growing bones. He irradiated the epiphyses and epiphyseal lines in animals during the period of growth, and found that with a sufficient amount of irradiation, most serious disturbances in growth may occur.

Bisgard has recently done similar work and has shown much the same result—

that one can produce a complete stoppage of growth in a long bone as a result of irradiation, with, of course, the resultant deformity that one might expect

I think it is important, however, to realize that in the vast majority of these cases of traumatic injuries, very likely no untoward results will occur

CASE REPORTS AND NEW DEVICES

BILOBED GALL BLADDER

(VESICA FELLEA DIVISA)

By LAWRENCE M. HILT, M.D.,

Roentgenologist, St. John's Hospital, Springfield, Ill.¹

Anomalies of the gall bladder in the human being are rare. We are indebted to Boyden (1), who has made an extensive study of the gall bladder in both animals and man. Recently Gross (2) published a very comprehensive article listing six cases of bilobed gall bladder which he was able to find in the literature, only one of which was diagnosed by cholecystography. An additional case that was recognized by the above procedure and confirmed at operation is submitted.

The roentgenologist should be familiar with these malformations in order that an unusual shadow of the gall bladder may be correctly interpreted. With the increasing use of cholecystography, it is probable that these anomalies will be found with greater frequency. Boyden found cats had bilobed gall bladders in about 10 per cent of the total number he examined.

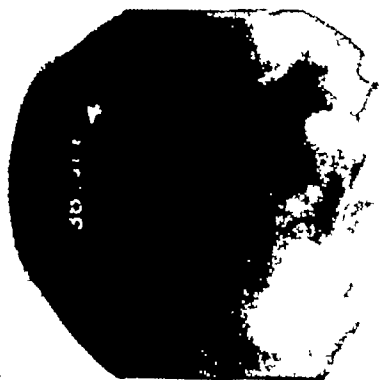


Fig. 1 Four hour film

Embryologically, a bilobed fundus is explained as follows. The single bud becomes paired, but a primary connection is maintained, thus forming two separate and distinct fundi with a single cystic duct. In two of the previously reported cases, the external appearance of the gall bladder showed quite a longitudinal septum. In the others and our own case, there are two separate cavities.

The clinical evidence is not characteristic of an anomaly.

CASE HISTORY

Female patient, aged 37 years, complained of a pain in the abdomen, with no particular

¹ Now Roentgenologist, Butterworth Hospital, Grand Rapids, Mich.

relation to type of food or time of eating. There was no history of vomiting, or jaundice. She had lost about thirteen pounds in weight in six months' time. Physical examination was normal, except for tenderness on palpation of the abdomen, particularly on the right side. The pain seemed to radiate equally in all directions. Blood count was within normal limits. Gastric analysis at the end of fifty minutes gave 25° free hydrochloric and a total acidity of 45°. Occult blood, lactic acid, and microscopic examinations were negative.

Roentgenoscopic and radiographic examinations of the gastro-intestinal tract revealed no abnormalities. A plain film of the gall-bladder area showed no demonstrable pathology. The gall-bladder dye was given intravenously, radiographic observation being made at four and six hours and one hour after a fat meal.



Fig. 2 Six hour film

The interpretation of the films was as follows: 'The gall-bladder shadow can be definitely outlined four hours after the intravenous administration of the gall-bladder dye. The gall bladder appears to be divided into two parts. This is further visible at the end of six

hours One hour after the fat meal, this division of the gall-bladder shadow can be more clearly outlined, the gall bladder having emptied itself over 80 per cent The diagnosis arrived at is bilobed gall bladder "



Fig 3 One-hour after fat meal

At operation a bilobed gall bladder, with one cystic duct, was found A partial cholecystectomy was done The appendix was removed Pelvic examination at operation revealed no evidence of pathology The abdomen was closed, with a cigarette drain in place The patient made an uneventful recovery, with relief of the previous complaints

The gross and microscopic descriptions of the gall bladder, as reported by Dr F W Light, pathologist, are as follows

Gross Examination—The specimen is the distal two-thirds of a gall bladder It has an unusual shape, the fundus being divided into two lobes of about equal size Collapsed, the specimen measures $4 \times 3.5 \times 1$ cm, and weighs 6.5 grams, most of its external surface is smooth and it has a deep pink color The gall-bladder wall is fairly thin and pliable, the mucosa is reddish-brown in color, no stone is present.

Microscopic Examination—The sections are taken from the edge of the specimen, and include parts of the proximal portions of both lobes of the fundus There is present a rather thick layer of subserosal fibrous tissue The muscularis is broad and shows interstitial fibrosis The mucosa is considerably flattened out, the epithelium being well preserved Scattered through the muscularis are a few narrow sinuses lined by epithelium

There is, thus, chronic inflammation, as well as an anatomical anomaly of the gall bladder The appendix is normal

Grateful appreciation is hereby expressed to Dr C W Compton for the clinical data and operative details of this case

SUMMARY

- 1 Bilobed gall bladders in the human are rare
- 2 Careful study of roentgenograms may



Fig 4 Gross specimen

reveal the true nature of this lesion prior to operation or postmortem

3 An additional case is added to those previously reported

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A CHEST CRADLE FOR THE ROENTGEN EXAMINATION OF THE FEMALE BREAST

By J GERSHON-COHEN M D
Philadelphia

The possibilities of studying mammary disease roentgenographically seems very promising To overcome some of the technical difficulties involved in making roentgenographic examinations of the female breast, a chest cradle was devised so that duplicate roentgenograms could be obtained, standardizing the technic and making possible the study of growth of any tumor or the effect of any form of medical or radiologic therapy

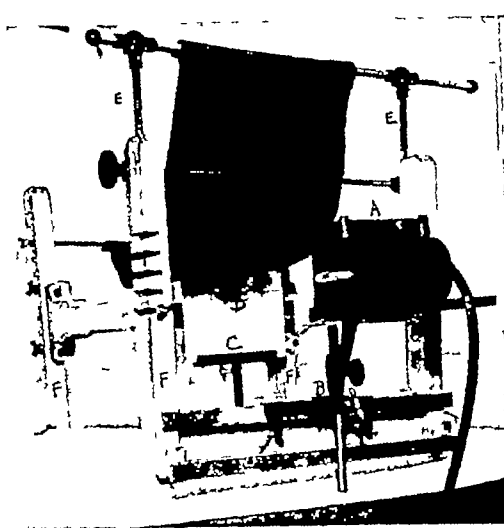


Fig 1

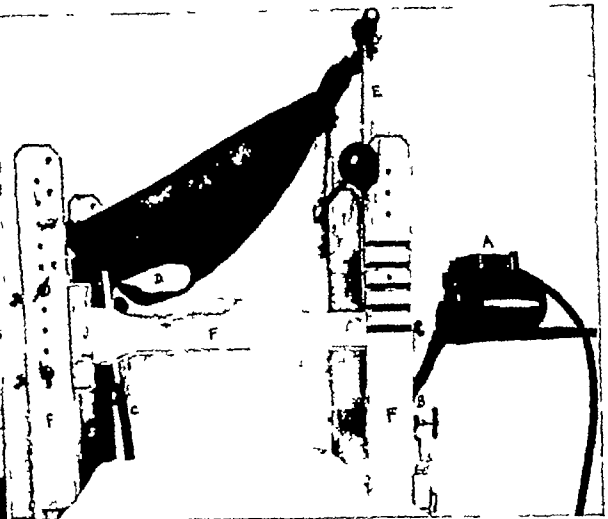


Fig 2

Figs 1 and 2 (a) Shockproof oil immersed x-ray tube, (b) mounting and carriage for the x-ray tube, (c) plate holder with a telescopic arm, (d) opening in canvas sling, (e) notched arms bearing cross piece to which one edge of suspension canvas is attached making possible the elevation of one side of torso so that a view of the opposite breast is clear, (f) supporting posts



Fig 3



Fig 4

Fig 3 A roentgenogram of a mammary gland made with the old technic, showing a growth in the upper region of the breast, found by the pathologist to be a scirrhus carcinoma

Fig 4 The same breast as examined with the use of the chest cradle showing the growth in its more natural architectural relationship to the whole mammary gland, two irregularly outlined cords of infiltration being prominently visible in the upper portion of the breast

The apparatus consists of four posts which can be made of any material that is sufficiently rigid to bear the weight of the heaviest



Fig 5 Patient in position to be examined resting on knees, body suspended prone on canvas hammock with breast hanging vertically through opening, the other breast is rotated upward, as the side of the patient's body is elevated opposite to that to be examined removing all interference with the projection of the beam of x rays

person on a canvas sling suspended from cross-bars. One of these crossbars itself is attached to vertical supports which are movable in ratched grooves in two of the posts so that elevation of one edge of the canvas sling is possible when desired.

By raising the edge of the canvas opposite to the side of the breast that is to be examined, interference with the horizontal central beam of x-rays is avoided as it traverses the breast tangentially to the chest wall. While diverse methods can be adapted for placing the film in position, we simply use a stand with a telescopic plate holder device which can be placed in position and elevated to the desired height, being necessarily changeable with different sized breasts. A plate tunnel can be used when stereoscopic films are desired. A light shockproof, fine focus, portable x-ray head and tube is used as our source of x-rays and this is supported on a carriage attached to a cross member, movable in both the horizontal and vertical planes so that the central ray can be directed along any desired line.

NON-TRAUMATIC DILATATION OF THE UTERINE CERVICAL CANAL

By W H McGUFFIN M D, *Calgary, Alberta, Canada*

In an article entitled "Technic of Radium Treatment of Cervical Cancer," Dr Frank E Simpson, of Chicago,¹ advocated a method whereby the least possible irritation to the malignant tissues would ensue. I was keenly impressed but as I did not have available a supply of radium emanation or radium cells which could be utilized in a small caliber flexible lead applicator, some substitute method had to be devised.

After a search an economic and highly efficient non-traumatic cervical canal dilator was discovered, or maybe I should say re-discovered. This dilator (Fig 1) is known as "The Sea-tangle Tent Dilator,"² but at the Radium and X-ray Institute in Calgary, it is known as "The McGuffin Dilator."

"The Sea-tangle Tent Dilator" has been found to be of value because

- (1) There is no pain to the patient

- (2) No analgesic or anesthetic is necessary for its introduction

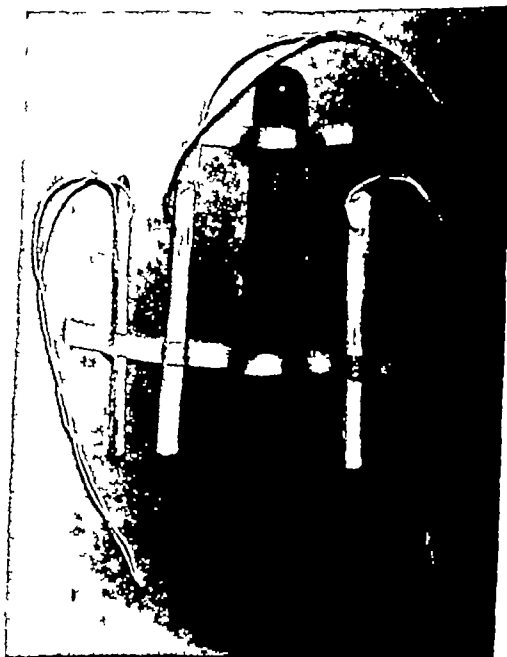


Fig 1

¹ Am Jour Roentgenol and Rad Ther, Vol 27, 775

² Procurable from the American Specialties Co. Inc 131 E 23d St., New York, or from Ingram & Bell Ltd, Toronto, Canada

(3) No instrumentation, no grasping of the cervical tissues with a tenaculum, or forceful dilatation with metal dilators

(4) The dilator is easy to sterilize, in fact, the manufacturers are now supplying the dilator in sterile oil enclosed in a hermetically sealed glass tube

(5) The dilator is supplied in various sizes, so that a dilator of the proper size may be selected

(6) Easy introduction

(7) No bleeding, because there is no bruising of the tissues

(8) No dissemination of malignant cells, because there is no trauma

TECHNIC FOR USING "THE SEA-TANGLE TENT" DILATOR

(1) Patient is prepared as for a surgical dilatation and curettage

(2) Patient is placed in the lithotomy or knee-chest position

(3) Speculum is introduced into the vagina. Tissues of the cervix and vaginal vault are cleansed by the application of swabs using 1:2500 metaphen solution

(4) A flexible uterine sound is passed to determine the length and direction of the uterine canal. This is the only instrumentation and is necessary for the determination of the linear dimension of the uterine canal in order that the technician may prepare the radium applicator with the proper number of radium centers, and, if necessary, an angulator to secure easy non-traumatic introduction of the radium applicator

(5) The size of the external os is determined and the proper size of dilator is selected, that is, one which can be passed into the canal easily

(6) The sterilized dilator is then soaked in 1:2500 metaphen solution for a few minutes until it is soft enough to be pliable

(7) The pliable dilator has a long string threaded at one end. A pair of long handled forceps take hold of the string end of the dilator and, under good light, the dilator is passed into the cervical canal without force

(8) The vagina is now tightly packed with sterile gauze strips, which are left in place for 24 hours

(9) The radiotherapist then removes the packing and the dilator. It is interesting to notice the size of the dilator at this time. It has increased in caliber at least three or four times. The tissues are now swabbed clean and the radium application made immediately

THE MOST ADVANTAGEOUS TIME TO USE THE SEA-TANGLE TENT DILATOR

(1) When the external os can be distinctly seen

(2) Only after thorough preparation of the parts as for surgical procedure

(3) When immediate radium application to the intra-uterine tissues is planned. The dilator is not to be removed until radium application is to be made, that is, approximately 24 hours after the introduction of the dilator. If the canal is not sufficiently dilated to take the radium applicator, then it would be advisable to use a larger dilator and wait a further 24 hours before making the radium application. It is not advisable to remove the dilator at the end of 24 hours and then to wait for 48 or 72 hours before administering the radium, because there is a tendency for the uterine canal to contract considerably after the dilatation process

(4) At the time of biopsy. It has been the experience of those making intra-uterine radium applications that certain types of biopsy section procedure so mutilate the cervical tissues in the region of the cervical canal that when the radium treatment time arrives the external os is obscured, or the canal distorted. Either of these two factors handicap the successful intra-uterine radium treatment. If at the time of the biopsy, the external os can be visualized, it would appear that this is the best time to use the dilator. Should the planned treatment call for external irradiation before the local radium application, then it will be necessary to repeat the dilatation procedure immediately before the introduction of the intra-uterine radium applicator

(5) In case there is a large fungating mass or deep crater ulcer at the site of the cervix, it will be impossible to use the dilator because the external os will not be visible. It will be necessary to wait until these conditions have been so altered by local or external irradiation, or following the removal of the overgrowth tissue by electrothermic methods, that the opening into the cervical canal is patent before attempting to introduce the dilator

CONTRA-INDICATIONS

(1) Severe infections which would prohibit immediate intra-uterine irradiation

(2) Thick cicatricial tissue encroachment upon the cervical canal, as exemplified by the following case

The dilator had been introduced into the cervical canal and 24 hours later I attempted to remove it. The dilator seemed to fit the canal very snugly and did not budge upon the gentle traction usually made upon the string attachment. Mental perturbation was experienced and I had visions of necessary surgical procedure. The dilator had become greatly swollen but was soft, so by a slow-motion, unscrewing procedure, the pessary was delivered with

satisfaction to all. It had been fixed within the canal by a circular constriction. This is one case probably in which forceful graduated dilatation by the use of metal dilators might have been advantageous, but such occurrences must be extremely rare. The outcome was favorable and the radium application was made without further interruption.

SUMMARY

(1) An economical and painless cervical canal dilator is brought to your attention.

(2) A technic for dilatation of the cervical canal is described which is non-traumatic.

(3) The method is practical as proven by me during several years of daily utilization.

224 7th Ave. West

A RADIOGRAPHIC DEVICE FOR THE ANTEROPOSTERIOR MENSURATION OF THE ETHMOIDS AND SPHENOIDS

By S. FINEMAN, M.D., M.A., New York City

Accurate information regarding the posterior extent of the ethmoids and sphenoids may be of considerable clinical importance to the rhinologist in the medical or surgical treatment of

ject placed in the same plane as the part radiographed will be magnified on the roentgenogram in the same relative degree as the part under examination.

Figures 1, 2, and 3 illustrate a measuring device and the resulting roentgenogram. The ruler, as shown in these illustrations, is cut from a piece of one-sixteenth or one-eighth inch of lead and is notched in centimeters. This lead ruler is then tacked on to a strip of wood, which, in turn, is tacked on to another narrow strip of one-sixteenth inch lead at right-angles to the ruler. This second strip of lead is inserted at the upper end into the clamp of a head mirror band, as shown in Figure 2. The end of the lead strip is shaped around a small ball bearing, so that it can be grasped firmly by the clamping device of the head mirror band.

The lower end of the lead strip can be shaped to fit under the patient's chin, where it can be held in place by a strip of adhesive plaster (Fig. 2).

Before adjusting this measuring device to the patient's head, nose, and chin, a narrow and thin strip of lead is molded to the patient's nose and is held in place with a strip of adhesive plaster. This is for the purpose of out-



Fig 1 Shows the lead ruler measuring device adjusted in the mid-sagittal plane of the head

Fig 2 Shows a profile view of the head with the lead ruler in position and the strip of lead molded to the nose

these sinuses. To the best of the writer's knowledge, radiographic mensuration of these sinuses is not being practised to-day.

The method here proposed is based on the well-known radiographic principle, that an ob-

ject placed in the same plane as the part radiographed will be magnified on the roentgenogram (Fig. 3).

The sinus roentgenogram can then be made with the patient in the sitting or horizontal position. In either case it is important to

adjust the patient's head and lead ruler so that the thin edge of the ruler coincides with the mid-sagittal plane of the skull, and so that both

the ethmoids or sphenoids is carried out as follows A celluloid ruler is placed on the roentgenogram so that it extends from the

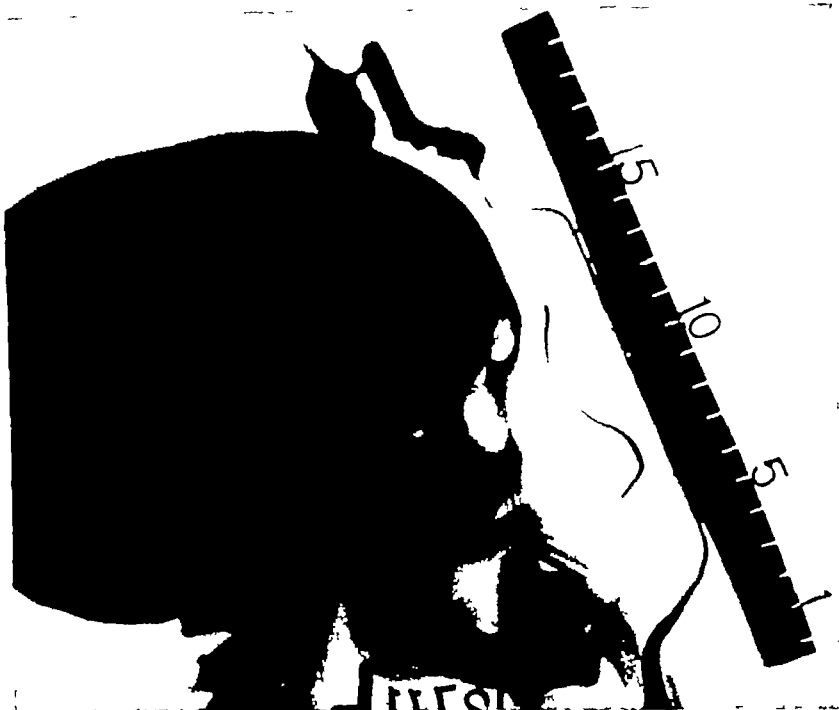


Fig 3 Shows the roentgenogram of the skull with the ruler in position, and lead strip over the nose. The centimeters on the lead ruler and the cranial structures in the mid sagittal plane of the skull show practically the same magnification

the mid-sagittal plane of the skull and flat surface of the ruler are parallel with the film. This avoids distortion of the ruler and of the skull structures on the roentgenogram and assures similar enlargement of the ruler and of the cranial structures which lie in the mid-sagittal plane of the skull. If the roentgenogram is made with the patient in the upright position, the weight of the device is sufficient to maintain its position in the mid-sagittal plane. In the horizontal position, small blocks of wood of suitable height can be used to support the lower end of the ruler at the proper level.

After the roentgenogram is obtained the determination of the anteroposterior depth of

tip of the nose to the sinus to be measured. The distance between these two points is noted. The celluloid ruler is then superimposed over the shadow of the lead ruler on the roentgenogram, on which this distance is read off directly in centimeters or fractions of a centimeter, as shown by the magnified centimeters on the lead ruler.

For clinical purposes the ethmoid cells and sphenoids can be considered as lying practically in the mid sagittal plane of the skull. The magnification of these structures on the roentgenogram is within practical limits, the same as the magnification of the lead ruler.

133 East 58th Street

EDITORIAL

LEON J. MENVILLE, M.D., *Editor*

HOWARD P. DOUB, M.D., *Associate Editor*

GROUP HOSPITALIZATION INSURANCE

THE STATUS OF RADIOLOGISTS IN RELATION TO THIS TYPE OF HOSPITAL PRACTICE

The majority of physicians in this country are well aware that one of the major problems facing them to-day is the attempted inclusion of the professional services of some of them in and as a part of the hospital benefits of group hospitalization plans. The services of radiologists have been included in the group hospitalization insurance plans of Cleveland for some three years and of New York for some two years. Since these hospitalization insurance plans are under lay control and since corporations cannot practise medicine, the implication is that radiology is a hospital and not a medical procedure. Fortunately, in most communities, the weight of opinion of the organized medical profession has been sufficient to persuade persons interested to exclude radiology and other forms of medical practice from these plans. In this connection, it is noteworthy that the first and oldest successful group hospitalization plan, namely, the Baylor Plan, never has had radiology amongst its benefits.

Within recent months there have been two encouraging developments. The first of these is the establishment of the Alameda County Group Hospitalization Plan, wherein radiology is provided to subscribers, but is provided on a legal and ethical basis. In this plan the Association indemnifies the subscriber to pay his radiologist for such services as are necessary while the subscriber is hospitalized. In this manner the patient personally pays the physician (that is, the radiologist) who provides the x-ray services, thereby complying with the law, and helping indirectly to uphold the status of radiology. Secondly, the Group Hospitalization Plan of Memphis, which formerly included discounts for x-ray work, now excludes such as being contrary to the ethics of the American Medical Association and contrary to sound medical practice. This revision was secured by the constructive co-operative efforts of the local county medical society.

These facts are being brought to the attention of all the members of the Radiological

Society of North America, and especially to the members resident in New York City and Cleveland. We believe that the Counselors of these two districts should bring these important developments to the attention of all radiologists in their respective districts to the end that the various county medical societies located therein be notified. Following this notification, the Executive Committees of those county medical societies should be requested to approach the hospital authorities to the end that the existing evil situation be corrected. The exact wording of the Alameda County Medical Society Hospitalization Policy can be secured by writing the Secretary, care of the Samuel Merritt Hospital, Oakland, California, the details of the Memphis Hospitalization Policy revision can be secured from the Secretary, the Shelby County Medical Society, Memphis, Tennessee.

L. HENRY GARLAND, M.D.

COMMUNICATIONS

Nov 30, 1936

Dr. E. J. Bertin,
Philadelphia, Pa.

Dear Doctor Bertin:

The phenomenon described as "pneumothorax in the newborn" ¹ has undoubtedly been observed by numerous radiologists, who, as myself, have not considered it to be of such etiology. Upon first consideration, the interpretation seems to be that of minimal pneumothorax, but the perplexing incongruity of a history of normal delivery, no attendant dyspnea or cyanosis, or other respiratory embarrassment, and an absence of physical signs are mainly instrumental in the reluctance to diagnose this "sign" as unqualifiedly due to pneumothorax. Many of the cases encountered by the writer were observed in the routine

¹ Paper entitled *Pneumothorax in the Newborn* by E. J. Bertin. *RADIOLOGY* November 1936, 27, 584.

chest examination for so-termed enlarged thymus. It is not my intent to question the diagnosis of pneumothorax in most of the cases reported, but merely to determine whether the mere existence of a peripheral pulmonary strip of radiolucency could not be simulated by other conditions, in lieu of pneumothorax. Since this sign is not an infrequent finding, is it not possible, or probable, that whenever incomplete inflation of the lungs of the newborn occurs, this appearance might be present, and under certain circumstances be somewhat different in roentgen appearance from true atelectasis? The *modus operandi* could be deficient thoracic contraction, with relatively greater diminution in size of pulmonary structure, causing an exaggeration in width of the normal potential pleural space. Again, the converse might apply, namely, incomplete expansion of the lungs. The rather high incidence of this phenomenon, and particularly its bilateral appearance, seems rather incredible if resultant of ruptured pleura and spontaneous pneumothorax. This is especially true in cases presenting no symptoms or signs. Since other serous cavities, *viz*, articular space of knee and shoulder, have been roentgenographically demonstrated without injection of air, under ideal conditions, is it not possible that this appearance in the newborn is visualized pleural space without introduction of air, its demonstration being enhanced by narrow chest, incomplete expansion of lungs, and coincidental exposure made at the extreme expiratory phase of respiration, as is frequently the case with the infant crying? The frequent association of strangulation by the umbilical cord, as reported by another author, would certainly suggest an etiologic factor of incomplete rather than excessive pulmonary expansion, with pleural rupture and ensuing pneumothorax. Of some seeming import is the fact that there is more frequent and greater involvement of the right side, although bilateral involvement is common. This might be explained upon the basis of insufflation of mucus, etc., into the bronchial tree, and due to the unique angulation of the carina, more frequently to the right side, which mechanical factor might also be ascribed to the rather common practice of placing infants upon their right side. Both promulgations favor the incomplete pulmonary expansion theorem.

The association of pleural exudate and pneumothorax is common, which, however, has not

been demonstrated in the paper or noted by myself. As explained in your paper, the roentgenograms are not customarily obtained with the infant in the erect position and a minimal amount of free pleural fluid might readily be overlooked or masked in the recumbent posture. Further studies with the examination made in the erect position may clarify this discrepancy. The infrequency of pleural infection, assuming the pneumothorax etiology, is not evidence *pro* or *con*, for the paucity of bacterial invasion of the lungs at this age is notable. In some of the cases presented, and in the writer's own experience, no classical roentgenographic signs of pneumothorax were definable, but again, this could be explained in the counterbalance of slightly increased intrapleural pressure, and opposing elastic recoil of the pulmonary structure. It might be added that, in certain instances, an inordinately rapid disappearance of this phenomenon occurred, which seems incompatible with absorption of pleural air.

In concluding, further study of this interesting phenomenon will attest to the validity of this sign as pathognomonic of pneumothorax, or demonstrate whether other factors might simulate this appearance. I wish to compliment you, Dr. Bertin, on your excellent presentation, and to concur with you in regard to the alleged artefact as productive of this sign.

With kindest regards,

Sincerely,

WILLIAM R. STECHER, M.D.

January 6, 1937

Dr. William R. Stecher,
Easton, Pa.

Dear Doctor Stecher:

I want to thank you for the very thorough discussion of my paper on "Pneumothorax in the Newborn," which I presented to the Radiological Society.

In that discussion you offered as an objection to the occurrence of pneumothorax, the fact that several of the cases occurred after "normal delivery." I am satisfied that under certain conditions there is sufficient pressure and force exerted on the fetus during many so-called "normal deliveries" to rupture an alveolus after air has entered the lungs, especially in the presence of obstruction in the pharynx, larynx, or bronchus, even though the obstruction be only temporary. The pressure exerted during active labor has been estimated by

various authorities as being between thirty and sixty pounds per square inch of surface

The degree of cyanosis or other evidences of respiratory embarrassment would naturally be dependent upon the amount of air in the pleural cavity, and upon the presence or absence of displacement of the heart and mediastinal structures. We have seen this beautifully illustrated on numerous occasions in adults with pneumothorax.

I cannot subscribe to your explanation of the appearances obtained in our cases as being due to an exaggeration in the width of the normal potential pleural space. If we admit of the presence of a demonstrable space, we should not refer to it as being potential. I am sure that the cases which we presented did not confuse potential with actual pleural spaces, and if the chest failed to contract as you suggest, I am sure that the lung and visceral pleura could not recede from the chest and parietal pleura unless some substance (such as air in our cases) entered the pleural cavity. One gets the impression from your explanation that a vacuum occurs in the pleural cavity, which, of course, is quite impossible. Before birth and in the still-born there is no visible pleural space. This, then, is a true potential pleural cavity and is kept so by contraction of the chest wall and elevation of the diaphragm, and remains in this condition until some substance, such as air, finds its way between the two pleural layers.

Our cases illustrate an actual and not a potential pleural space. I feel sure that after consideration of these few remarks, and a review of your discussion, you will see how inadequately you explain the phenomenon and appearances which we illustrated in the seven cases presented in our paper.

Let me again thank you for your lengthy and interesting discussion. Hoping that some keenly observing obstetrician may detect definitely the manner in which this fascinating, if not important, condition is produced, by careful observation of the newborn during and immediately after even so-called "normal deliveries," I remain,

Very truly yours,
E J BERTIN, M D

DISCUSSION¹

DR PHILIP J HODES (Philadelphia) The importance of this subject is self-evident and

¹ Discussion of Dr Bertin's paper after its reading at the Cincinnati meeting

we feel that Dr Bertin has done justice to it. One pitfall in diagnosis of pneumothorax in the newborn child merits further discussion.

Sometimes in holding the child for chest examination, the skin on the chest may be accidentally folded on itself. The roentgen manifestation of this artefact has been confused with pneumothorax. In order to satisfy ourselves that folds of the skin could simulate pneumothorax roentgenographically, we made roentgenograms of the chest of healthy infants. Following these routine exposures, the skin was deliberately folded and roentgen changes similar to those of pneumothorax were produced.

While pneumothorax in newborns undoubtedly does occur, the possibility of this artefact as a source of error must, consequently, be kept in mind.

DR E J BERTIN (closing) I agree with you that caution must be used in making a diagnosis of pneumothorax. You have pointed out and illustrated with lantern slides, an appearance which might possibly be mistaken for pneumothorax, but on close inspection definite evidence of pressure effect could be seen. Either the outline of the upper arm or the fingers of a nurse or assistant were clearly visible in your illustrations.

We also have seen these pressure effects many times, not only in infants, but also in children and adults, but we have had little or no difficulty in recognizing them, especially because both of these structures contain bone. Besides, the convexity of the pleural margin in pneumothorax as contrasted with the straight or concave outline with the arm or fingers present, renders the differentiation quite easy. We made numerous films after folding the skin in various areas on the front and back of the chests of infants, fixing the folds with adhesive plaster, but the appearances obtained could not be confused with those illustrated by our cases.

TEXAS RADIOLOGICAL SOCIETY

The Twenty-fourth Annual Meeting of the Texas Radiological Society was held at Abilene, Texas, on Jan 16, 1937.

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30, and 31, 1937, at the College of Physicians and Surgeons, Columbia University, New York City Please note that the dates have been changed from those previously sent for publication and to be found in RADIOLOGY, September, 1936, p 375

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By EDWARD ADAMS, M D, Lt. Col U S
Army, M R C A volume of 168 pages, 62
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Price, \$2 00

This book, written by a distinguished New York surgeon, is an endeavor to be of service to the medical expert witness and to the lawyer who has to try bone injury cases, and in that respect the book is a decided success It is sure to become invaluable to those who are trying to estimate the degree of disability and to determine the percentage of permanent incapacity which is liable to remain as the end-result in fracture cases

As radiologists, we are frequently called upon to estimate the amount of permanent disability which is liable to occur in the end-result in fractures These requests are becoming more frequent in the instances in which we appear before Industrial Commissions, and with the information to be gathered from this book we will be much better prepared to make these estimates in a manner to the satisfaction of all concerned

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S M ATKINS, M D , of Waterbury, Conn	WILLIAM R STECHER, M D , of Easton, Penna
HANS A JARRE M D , of Detroit, Mich	W A SODEMAN, M D , of New Orleans, La
E T LEDDY, M D , of Rochester Minn	CHARLES G SUTHERLAND, M B (Tor) , of Rochester Minn

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GRENZ RAYS

The Technic of Grenz ray Therapy in Nevus Flammeus F Kalz *Strahlentherapie*, 1936, 57, 510

During the last few years the author has seen 49 cases of nevus flammeus 31 of those were fully treated and observed, three are still under treatment, and the others could not be traced Technic Single doses of from 800 to 1,100 r, 12.5 kv, 7 cm FSD, 15 ma, HVL in Al, 0.026 mm, 1,990 r/min, total doses of 10,000-12,000 r The results were so encouraging that the author recommends Grenz ray therapy in nevus flammeus as the best therapy available to-day

ERNST A POHLE, M D, Ph D

GYNECOLOGY AND OBSTETRICS

Relaxation of the Symphysis Pubis in Pregnancy Herbert Thoms *Jour Am Med Assn*, April 18 1936, 106, 1364-1366

Studies of various observers have revealed that relaxation of the symphysis begins in the first half of pregnancy, progresses but slightly in the last three months, and that retrogression begins immediately following delivery and is usually completed by the end of from three to five months There is no essential difference between the behavior of the pelvic articulations in primiparas and in multiparas

The author studied roentgenographically 100 primiparous women at different stages of pregnancy, and presents his findings in a table showing the variations in width observed In the first half of pregnancy the minimum spread was 0.2 cm and the maximum 0.6 cm, in the second half the minimum was 0.3 cm and the maximum 1 centimeter No relationship between the amount of symphyseal relaxation and the pelvic type was apparent

There is no doubt but that pelvic instability incident to pregnancy changes in the pelvic joints and associated with symptoms of discomfort is far more common than is usually supposed These symptoms may include pain in the symphyseal region, backache and localized pain in one or both sacro-iliac joints, and difficulty in normal locomotion One case is reported in which such pelvic instability assumed major proportions

CHARLES G SUTHERLAND M B (Tor)

The Indications for Radiation Therapy and Operation in Uterine Fibroid C Beclère *Strahlentherapie* 1936 56, 548

The author outlines briefly the indications and contra indications for radiation therapy of uterine fibroid Provided the diagnosis is correct, roentgen therapy gives good results regardless of shape and size of fibroid and age of the patient Determinations of the size of the tumor every eight days after treatment has been started is a valuable diagnostic aid If menopausal symptoms appear, particularly hot flashes and

the bleeding continues, careful search for possible carcinoma of the fundus should be instituted

ERNST A POHLE, M D, Ph D

The Utero-salpingogram as a Means of Differential Diagnosis in Gynecological Pathology George Lyford *Jour Med*, November, 1936, 17, 436-442

Lyford points out that the immediate objection raised to the use of the utero-salpingogram is its danger in producing more or less serious complications to the pelvic pathology existing However, in 1,752 examinations he has encountered only two complications, one an intra abdominal pregnancy and the other a twisted pedicle cyst Either of these conditions may have resulted from the examination or may have been purely coincidental However the percentage of complications is low and does not compare with the information it is possible to obtain Results are dependent upon the ability of the observer to interpret both the fluoroscopic findings and the films The fluoroscopic examination is an extremely important portion of the procedure One must consider the utero-salpingogram as a laboratory procedure not to be used except as giving additional information when correlated with the other laboratory and clinical data

W A SODEMAN, M D

HAY FEVER

Roentgen Therapy of Hay Fever Laquerrière *Strahlentherapie*, 1936, 57, 70

The author has seen some encouraging results in the treatment of hay fever by roentgen rays The following technic proved satisfactory 150 kv, 3 mm Al, 30 cm FSD, 150 r on the first and second days, to be repeated if necessary after five days, and 200 r after another five days if the condition of the patient requires it Total doses of 1,000 r have not been exceeded The eyes are covered with lead and the entire nose is in the field of exposure

ERNST A POHLE, M D, Ph D

HEART AND VASCULAR SYSTEM

Right sided Aortic Arch (Situs Inversus Arcus Aortae) D Evan Bedford and John Parkinson *British Jour Radiol*, December 1936 9, 776-798

Right sided aortic arch results from persistence of the fourth right embryonic arterial arch and the partial suppression of the fourth left embryonic arterial arch This condition represents a reversion to the avian type of aorta, and thus to the pattern normally found lower in the vertebrate scale.

Other congenital cardiac malformations, such as Fallot's tetralogy may be associated with right-sided aortic arch In uncomplicated cases the aorta arises normally from the left ventricle, but if combined with Fallot's tetralogy, it arises from both ventricles and lies

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are given weekly The entire course of treatments consists of 15 single sittings over a five-year period Patients with fever, cachexia, and those over 70 years of age are not suitable for this type of treatment

ERNST A POHLE, M D , Ph D

Atypical Roentgen Appearance of Pulmonary Infarction in Patients with Heart Failure Hyman Levy *Am Jour Roentgenol and Rad Ther*, May, 1936, 35, 635-639

In heart failure with pulmonary congestion many more infarctions occur than are realized because of either the failure to recognize them clinically or their atypical roentgen appearance The atypical situation and roentgen appearance are especially prone to be the case in pulmonary congestion, whereas the typical triangular density with the apex pointing to the hilum follows post operative emboli

The infarct density may persist for months or years Two atypical cases are presented and the literature reviewed

S M ATKINS, M D

Calcification of the Aortic Valve L Minor Blackford, William W Bryan, and Emory D Hollar *Jour Am Med Assn*, July 4, 1936, 107, 18-21

Calcification of the aortic valve was reported by Cowper in 1706, the gross appearance being beautifully illustrated at that time Excellent descriptions were also recorded by Vieussens, in 1715, and Morgagni, in 1769 Osler described the condition in 1893 Interest in the subject was revived by a report of 42 cases observed at necropsy by Margolis, Ziellessen, and Barnes in 1931 The clinical aspects were discussed by Christian, in 1930 and 1931, who announced that Sosman had perfected a technic for demonstrating the calcification by fluoroscopic observation The roentgenologic technic has since been described in detail by Sosman and Wosika (1933) To date, some fifty cases have been reported in the literature The authors add one case in which calcification of all cusps of the aortic valve had been observed in fluoroscopic study and the findings were verified by roentgenograms of the heart after necropsy

CHARLES G SUTHERLAND M B (Tor)

Epipericardial Fat Its Non recognition a Common Cause of Error in X ray Measurement of Heart Size Sylvester McGinn and Paul D White *Jour Am Med Assn*, July 18, 1936 107, 200, 201

Much reliance is placed on x ray measurement of heart size provided certain sources of error are recognized and taken into account The commonest cause of error has been that of distortion of the heart shadow by magnification when the x ray tube is too close to the heart This has been largely corrected by the use of the 6 to 7 foot (2 meters) distance from the film to the target

The shape and position of the heart should always

be considered, when making measurements The presence of a triangle of epipericardial fat at the cardiac apex may cause an error in measurement If this is included in the transverse measurement, it may cause an abnormal increase in the so-called cardiothoracic ratio, i e, the transverse measurement of the "heart" shadow may exceed half the internal diameter of the chest

When the pericardial diaphragmatic angle is not clearly outlined and especially if it is obtuse, one may be suspicious of the presence of epipericardial fat Fluoroscopic examination will often show two distinct shadows

CHARLES G SUTHERLAND, M B (Tor)

THE HIP JOINT

Transitory Synovitis of the Hip Joint in Childhood Jerome G Finder *Jour Am Med Assn*, July 4, 1936, 107, 3-5

Transitory synovitis of the hip joint in childhood often remains unrecognized despite its relatively frequent occurrence Usually the disease is erroneously diagnosed as tuberculosis of the hip Other terms employed to designate this disease are coxitis serosa seu simplex coxitis fugitive, coxitis ephemere, coxitis fugax, coxitis incertae causae and transitory arthritis of the hip joint An underlying, non specific infective focus is usually responsible Trauma resulting from a fall, muscular strain (tap dancing and track athletics), contagion (measles and scarlet fever) have been considered factors A definite syndrome of prodromal events for varying periods of time, followed by acute or insidious onset of limp pain night cries and restlessness with tenderness to pressure, limitation of hip motion, and positive Patrick and Trendelenburg signs, characterizes the disorder Roentgenograms are negative in their findings Treatment is essentially conservative

CHARLES G SUTHERLAND M B (Tor)

INFLAMMATORY DISEASES

Roentgen Therapy of Inflammatory Disease G Charmandarian *Strahlentherapie* 1936, 57, 187

The author recommends the use of roentgen rays in the treatment of inflammatory disease His results are essentially the same as those reported in the literature Doses of from 10 to 30 per cent E D (150 kv 5 mm Al or 0.5 mm Cu + 1 mm Al) are usually applied

ERNST A POHLE, M D Ph D

THE KIDNEYS

Pyelography of the Surgically Exposed Kidney Herman L Kretschmer and Fay H Squires *Jour Am Med Assn* July 18, 1936 107, 205

In the case reported a pre operative diagnosis of

somewhat to the right of its usual position. A right-sided aortic arch crosses the root of the right lung, instead of the left, and passes on the right side of the trachea and esophagus. It may descend the right side and cross the spine lower down. On the other hand, it may turn to the left behind the trachea and esophagus, after arching over the right bronchus. At this point an ampullary dilatation or a diverticulum is formed which pushes the trachea and esophagus forward and to the left. The left subclavian artery and sometimes the ductus arteriosus arises from this diverticulum. Below the level of the diverticulum the aorta may cross gradually to the left or it may pass to the right and then return to the left to reach the aortic opening in the diaphragm.

Two anatomical types of right-sided aorta have been recognized by Krause. In both types the aortic arch develops from the fourth right arterial arch. However, in the first type the proximal part of the left fourth arch persists as part of the left subclavian artery, while in the second type the distal portion of this arch forms an aortic diverticulum at the termination of the aortic arch, from which the left subclavian artery arises.

The radiological examination of right-sided aortic arch in the anterior position shows absence of the left aortic knob with the presence of a right aortic knob or a band like shadow in this region. The visualized esophagus will be observed to be indented and to the left side of the arch. In the right oblique position at the level of the arch the visualized esophagus curves sharply forward and lies in front of the arch and diverticulum. When no diverticulum is present the aorta may not pass behind the esophagus, which therefore, is not displaced. In the left oblique position it is observed that the aortic shadow in front of the trachea is wider than normal. The esophageal and tracheal displacement is less evident. The authors report eleven cases of right sided arch and discuss the radiological features.

J. N. ANÉ, M.D.

The Simplest Aortic Measurement and its Physiologic-clinical Significance. Siegmund Kreuzfuchs. *München med Wchnschr* April 24 1936, pp 681-683.

The author describes his most recent method of estimating the diameter of the aorta, and compares it to his earlier and well known method. Inasmuch as the trachea and esophagus on their left aspect lie in the same sagittal plane as the bending margin of the contiguous aorta, one can measure orthodiagraphically the horizontal distance from the most prominent point along the left side of the aortic arch or knob, to the left tracheal margin. This affords an exceedingly simple and reliable estimate of the aortic diameter at this level, which approximates the site of the branching off of the common carotid artery. This measurement is slightly larger than the designated aortic-esophageal diameter as obtained by the original Kreuzfuchs method due to the disparity in aortic diameters at the respective levels of the juncture of the common carotid

and subclavian arteries, which produce fusiform regional aortic widenings. At a focal film distance of 60 cm the measurement obtained by the new method is magnified and distorted, and the corrected measurement can be readily deduced by subtracting one-sixth of this distance. A focal film distance of 150 cm. requires a subtraction of one fifteenth of the measured width. The average diameter of the aorta at this site is from 30 to 32 mm in males and from 28 to 30 mm in females. Contrary to former opinions the aorta is not narrowed as age increases for estimates obtained reveal that at 20 years of age, the aortic width is two-thirds the transverse vertebral body segment at the level of the fifth thoracic vertebra, whereas at 70 years it is equal to the vertebral body width.

The great importance from a physiologic-clinical concept, is the fact that the aorta under normal conditions presents extremely slight variance, the measurements for similar age, sex, and height being very constant, therefore, any aberrations are to be looked upon with grave suspicion as indicative of disease.

WILLIAM R. STECHER, M.D.

A Multiloculated Non syphilitic Aneurysm of the Aorta. S. Baumeier. *Deutsche med Wchnschr* 1936, 62, 1369.

The author describes an aneurysm of the aorta which was found during roentgen serial fluoroscopic examinations in a girl 21 years of age. The clinical examination as well as the Wassermann reaction was negative for syphilis. The roentgenogram showed a thin radiopaque line in the upper border of the aneurysm corresponding undoubtedly to calcium deposit. The author believes that the etiology is to be found in a congenital defect of the blood vessel wall.

ERNST A. POHLE, M.D., Ph.D.

A Radiologic Study of the Heart in Abdominal Typhoid. Giuseppe Pellegrini and Franco Facci Tosatti. *Archivio di Radiologia*, 1936 12, 49-64.

In this study of 20 cases of typhoid, the authors used the method of Facci to measure the size of the heart and found that the size of the heart decreases 5 to 10 per cent during the course of the disease due to a pathologic state of the circulatory system which reduces the venous blood inflow to the heart.

E. T. LEDDA, M.D.

Roentgen Therapy of Angina Pectoris. R. Gilbert. *Strahlentherapie*, 1936 57, 203.

The author states that radiation therapy in angina pectoris offers definite clinical improvement in at least 50 per cent of all cases. High doses are to be avoided. He uses two large areas over the chest and one posterior area about 400 sq cm (180 kv, 0.7-1 mm Cu + 1 mm Al 50 cm FSD). He starts in with a surface dose of 30 r in order to test the reaction of the patient and then increases this dose to 50 or 75 r. Three sittings

lumen of the tube and interfere with drainage to such an extent that suppurative processes may mask the underlying disease. The chief factor in the more frequent antemortem recognition of primary malignant growths in the air passages has been the more general employment of bronchoscopy in the diagnosis and treatment of chronic pulmonary diseases and the removal of tissue for microscopic examination.

Roentgenographic examination revealed the presence of a lesion in 136 of the 140 cases reviewed in this series. In one case not recognized roentgenographically the tumor was situated in the trachea, in three others the lesion was situated in the lumen of a bronchus and examination failed to reveal the presence of the disease.

CHARLES G. SUTHERLAND, M.B. (Tor.)

Congenital Cysts of the Lung from the Roentgenologic Viewpoint B. R. Kirklin. *Am Jour Roentgenol and Rad Ther*, July, 1936, 36, 19-29.

Anatomically the cavities are either bronchial dilations or cavities resembling blebs lying subpleurally. Between these extremes are all sorts of gradations and transition types. They may or may not communicate with the bronchi, be single or multiple, contain air or fluid or both.

Clinically dyspnea, cyanosis, cough, cardiac palpitation, and (rarely) hemoptysis may occur, much depends on their size and location, and in the small cysts practically no symptoms may be present.

Roentgenologically the signs vary according to their content, size, number, location, and the presence or absence of complications. In most cases the more common diseases which they resemble, such as bronchiectasis, abscess, tuberculosis, dermoid or hydatid cyst, must be diagnosed, but this condition considered. The small multiple cysts and the larger single cyst should be more easily diagnosed correctly in view of the fine apparent non-inflammatory walls.

S. M. ATKINS, M.D.

LYMPHOGRANULOMA

Our Experience in the Treatment of Lymphogranulomatosis W. Bacus. *Strahlentherapie* 1936, 56, 541.

The author outlines briefly his experience in the treatment of Hodgkin's disease based on 23 cases seen during the period from 1925 to 1930 and 55 cases observed during the period from 1931 to 1936. He deduces from these figures that there is an increase in the occurrence of the disease although this might be explained partly by an improvement in our diagnostic facilities. As to the etiology, the author feels that Hodgkin's disease is probably a special type of tuberculosis. Radiation therapy should be applied as little as possible and only when necessary to keep the patient comfortable. The average dose per field is 150 r. Radium is as effective as roentgen rays but seems suitable only for superficial glands. The average duration of life in the author's cases was two years. However

some responded better to the treatment, one lived 11, three lived 6, three lived 4, and three lived 3 years after the diagnosis had been made.

ERNST A. POHLE, M.D., Ph.D.

MASTITIS

The Value of Roentgen Therapy in the Treatment of Puerperal Mastitis C. Margraf. *Strahlentherapie* 1936, 57, 303.

The author relates his experience with the treatment of puerperal mastitis by roentgen rays. Technic: 115 r per sitting, 172 kv, 0.5 mm Cu + 1 mm Al, 30 cm F.S.D., 48.6 r per minute. This dose is repeated after 48 hours, provided the first exposure did not bring complete relief.

The author's material consisted of 245 cases, 127 were treated conservatively and 118 patients were treated by roentgen rays. Subtracting those cases that were too far advanced for irradiation, the percentage of cure without surgical intervention amounted to 81 per cent. It is important to treat the patients early, that is within 24 hours after the first symptoms.

ERNST A. POHLE, M.D., Ph.D.

MEDIASTINAL DISEASES

Radiation Therapy of Mediastinal Diseases in Children R. Sarasin. *Strahlentherapie*, 1936, 57, 140.

The author gives an outline of the dosage and technic used in the treatment of mediastinal diseases in children. In hyperplasia of the thymus, 30 r every two to five days are given. The dose may be increased to from 50 to 80 r. Deep therapy technic is used, the total dose does not exceed 300 to 700 r. In malignant tumors of the thymus, 70 r are given daily over from two to four areas, depending on the age of the child. A total dose of 5,000 r usually suffices to bring about regression of the neoplasm. In lymphosarcoma, 50 r are given daily and may be increased later to 150 r. The blood picture has to be checked carefully. In Hodgkin's disease treatments are given once or twice daily, 100-180 r per sitting with total doses up to 3,500 r. In lymphatic leukemia, general body exposure seems to be the method of choice, from 8 to 15 r per sitting should not be exceeded. The enlarged glands sometimes require local exposure of from 50 to 100 r every three days. Enlarged tracheobronchial glands may respond to from 40 to 80 r per sitting given twice weekly up to 1,500 r over a six to eight weeks' period. Pott's disease is treated with a similar technic. In tuberculosis of the hilum glands as well as in mediastinal pleuritis roentgen therapy is contra-indicated. There are a number of lesions which might be erroneously diagnosed mediastinal tumors as for instance congenital diseases of the heart, idiopathic dilatation of the esophagus, cysts and ectopic lobe of the thyroid gland. Radium may also be used but only in the form of telecuri-therapy with one or more grams of radium.

ERNST A. POHLE, M.D., Ph.D.

right renal tuberculosis was made without the benefit of ureteral catheterization or intravenous urography. At operation the kidney appeared normal. Ten centimeters of diodrast was injected into the unopened pelvis and a roentgenogram was made. This showed findings indicative of renal tuberculosis and all doubt about the propriety of nephrectomy was removed.

CHARLES G. SUTHERLAND M.B. (Tor.)

THE KNEE JOINT

Roentgen Therapy of Extensive Periarthritis of the Knee Joint. G. Huc and P. Aime. *Strahlentherapie*, 1936, 57, 270.

The authors recommend the use of roentgen therapy in periarthritis of the knee joint. They have used it in over 300 cases and developed the following technique. They begin with 75-125 r (0.5 mm Cu + 1 mm Al, 30-40 cm F.S.D.) and increase this slowly to 200-250 r per field. One area is given per sitting with a total of two lateral, one anterior and one posterior field. The total dose amounts to from 1,500 to 2,700 r over four areas, i.e., 375 to 675 r per field. The entire treatment takes three or four weeks, at least seven, but not more than twelve, sittings should be given. A slight reaction sometimes occurs after the first exposure. As a rule one series of treatments sufficed; in 6 per cent only of the cases was the second necessary. Improvement should be noticeable after the fourth treatment. Appended roentgenograms show that, although the radiological findings were unchanged after the treatment, the clinical improvement was most satisfactory.

ERNST A. POHLE M.D. Ph.D.

THE LUNGS

Diagnosis and Treatment of Pleural Empyema. Richard Goldhahn. *München med. Wchnschr.* April 24, 1936, pp. 676-678.

A brief review of clinical signs and symptoms is given, the author cautioning against heavy percussion which might produce no elicited dullness due to empyema being percussed through. Diagnosis is imperative and fairly good sized encapsulated empyemas can be overlooked. Roentgenograms are therefore essential, particularly in localization of encapsulated interlobar collections of fluid. Another useful function of x-ray examination is the determination of whether or not pneumothorax is present.

Paracentesis thoracis is useful only for diagnostic purposes and drainage should not be attempted from this alone. Especial caution should be taken to prevent entrance of air into the pleural space. The rationale of a closed drainage is well outlined, by showing how a so-called 'low encapsulated empyema' is produced in contradistinction to a high empyema when a pneumothorax is produced—for the air goes to the apex of the pleural cavity, preventing expansion of the lung apex, and thereby producing an elongated path from this cephalad portion of the empyema to the

drainage site. This entity the author calls a 'high situated empyema.' Inasmuch as paracentesis alone is rarely effectual, the author recommends early thoracotomy of the closed type which permits the lung apex to expand first. Other advantages of the latter are the prevention of venous stasis and cyanosis, as occasionally occurs when a pneumothorax is present preventing re-expansion of the lung.

WILLIAM R. STECHER, M.D.

Congenital Cystic Disease of the Lungs. A Clinicopathological Study. Samuel George Schenck. *Am. Jour. Roentgenol. and Rad. Ther.* May, 1936, 35, 604-629.

This disease is now an established clinical entity readily recognized during life. In infants and young children the prognosis is grave, in older patients thoracic surgery such as lobectomy offers hope.

The symptomatology depends on the size of the cyst or cysts, their location and whether or not they are infected. Cough, dyspnea, cyanosis and expectoration are commonly found, fever, malnutrition, thoracic pain, hemoptysis, weakness, wheezing, anorexia, palpitation, and vomiting may also occur. When infection occurs suppurative symptoms naturally supervene. Some patients may have no symptoms at all.

Roentgenologically, if the cyst be solitary and fluid containing it is an ovoid opaque area in the parenchyma of the lung and remains unchanged over a long period of time. Following rupture a horizontal fluid level is seen with air above. With the fluid completely replaced by air the wall is seen and appears thin. Fine strands in wide sweeping curves are frequently seen traversing the cyst.

The multiple cysts which are usually smaller than the solitary, may be scattered in more than one lobe and, except for the history dating back to infancy, are more difficult to differentiate from acquired bronchiectasis. An artificial pneumothorax will differentiate a large cyst from pneumothorax by demonstrating the cyst within the lung.

The literature of this condition is reviewed, 232 cases analyzed and 4 new cases presented and described in detail covering the history, incidence, etiology, pathology, classification, clinical types, symptoms, clinical course, roentgenologic findings, differential diagnosis, complications, prognosis and treatment.

S. M. ATKINS, M.D.

Primary Malignant Disease of the Tracheobronchial Tree. Report of 140 Cases. Porter P. Vinson. *Jour. Am. Med. Assn.* July 25, 1936, 107, 258-260.

Metastatic nodules in the lungs, even though they may be large and numerous, rarely produce signs or symptoms of pulmonary disease unless they involve the pleural surfaces and cause pain or effusion into the pleural space. They may be unsuspected until a roentgenogram of the thorax reveals their presence. A small growth arising in a bronchus may soon reduce the

336 patients with peptic ulcer Forty-one were located in the small curvature, 41, in the pyloric region, 133 had duodenal ulcer, seven had ulcers in the duodenum and in the small curvature, 25 had periduodenitis, 25, jejunal ulcer following gastro-enterostomy, 16, gastrojejunitis, 18 strictures in the pylorus with peptic ulcer Technic one anterior and one posterior area of 10×15 sq cm, 30 cm FSD Each field receives twice 225-250 r at four- to six day intervals Following this local irradiation the celiac ganglion is irradiated A field 8×15 cm in the region of thoracic vertebrae 5 to 12 receives two exposures of 225-250 r each at 4- to 6-day intervals Patients with chronic constipation are treated, in addition, over two areas in the lumbosacral area The results were gratifying 38.8 per cent were cured and 52.43 per cent improved, 8.68 per cent remained unchanged

In conclusion, the authors state that roentgen therapy applied according to their method is the method of choice in treating peptic ulcer It should be given a trial before operation

ERNST A. POHLE, M.D., Ph.D.

RADIUM

Investigations Regarding the Problem of Radium Poisoning I Toxic Quantities of Radium Introduced into the Human Body B. Rajewsky Strahlentherapie, 1936, 56, 703

The author undertook a series of measurements in persons with radium poisoning and compares his results with those published in the literature He establishes as toxic dose for the internal application of radium the quantity of one microgram radium element of 'Restradium' The tolerance dose for internal radium administration is also discussed

ERNST A. POHLE, M.D., Ph.D.

Measurement of the Doses in Radium Therapy J. Murdoch, E. Stahel, and S. Simons Strahlentherapie 1936, 57, 87

The authors use the roentgen in expressing their doses in radium therapy According to their measurements 1 mg of radium filtered through 1 mm Pt emits 7.62 r per hour at 1 cm distance They publish a number of tables which permit the determination of the dose applied for various types of radium moulds at distances of 1, 2, 3, and 5 centimeters

ERNST A. POHLE, M.D., Ph.D.

Effects of Radiation on the Cadaver (Radiothanatologie) G. G. Palmieri and G. Paltrimieri Strahlentherapie 1936, 57, 94

The authors propose and have started an extensive program of research dealing with the effect of various types of radiation on the cadaver, and in this paper they briefly describe a few of their preliminary experiments and findings Heavy irradiation by radium rays did

not produce any microscopic changes in the skin of a dead human being, if given within three hours postmortem This suggests the use of the procedure as a test for death

ERNST A. POHLE, M.D., Ph.D.

A Combined Radium Localizer R. Werner Strahlentherapie, 1936, 57, 385

The author describes a radium bomb developed in his clinic It is constructed in such a manner as to require only relatively small amounts of radium element (300 mg) At 5 cm the output is 78 r per hour, and with 500 mg 126 r per hour Assuming the intensity at 5 cm distance would be 100 per cent, it amounts to 37 per cent at 10 cm Photographs of the entire apparatus and isodose curves in r per minute for 300 mg element are shown with the article

ERNST A. POHLE, M.D., Ph.D.

A Cyclic Occurrence of the Radium Erythema and a Paradox "Pale Reaction" Following Radium Exposure of the Comb and Wattles of the Rooster Due to Changes in the Collagen E. Zurhelle Strahlentherapie, 1936, 57, 473

The author studied the reactions of the skin in man and on the comb and wattles of roosters, both microscopically and macroscopically following exposure to gamma rays of radium He found that the erythema reaction appeared in cycles while the microscopical studies showed marked changes in the collagen of the connective tissue Based on his observations, he proposes a classification of the reaction in five different stages For details see the original

ERNST A. POHLE, M.D., Ph.D.

Late Results of Radium Therapy of Cavernous Hemangioma in the Face of Children. F. Perussia Strahlentherapie, 1936, 57, 109

The author relates his experience in the treatment of hemangioma of the face with radium Several case histories are briefly quoted and photographs of eight cases before and after treatment show the results obtained by this method

ERNST A. POHLE, M.D., Ph.D.

Radium Therapy in Angioma Planus A. Marin Union Med. du Canada May, 1936, 65, 446-449 (Reprinted by permission from British Med. Jour., Oct. 3, 1936, p. 55 of Epitome of Current Medical Literature.)

The author maintains that the treatment of angiomas differs according to their variety The stellate forms respond well to the galvanic cautery, electrolysis, electro-desiccation and carbonic snow In the tuberous forms which are globular, more or less prominent and of variable size, radium, applied either externally or by puncture gives excellent results—radium puncture is the preferable method The radium-containing needle should be introduced into the middle of the

MYOSITIS OSSIFICANS

Traumatic Myositis Ossificans The Result of Injury or Treatment? Lorenz Böhler München med Wehnschr, April 10, 1936, p 594

The author concludes that myositis ossificans, if making its appearance fairly early after an injury is not the result of the trauma *per se*, but is mainly caused by the treatment. This, he states, is due to the commonly practised excessive early massage and passive motion of the affected part. He considers healing to be enhanced by therapeutic *noli me tangere*, and condemns medico- and physio-therapeutics.

WILLIAM R. STECHER, M.D.

OSTEOMYELITIS

Osteomyelitis of the Inferior Surface of the Petrous Pyramid Wells P. Eagleton Jour Am Med Assn, Aug 15 1936, 107, 482-484

Apicitis is a generic term, covering a large number of different pathologic states, the symptoms of which are modified by the surrounding parts. Because of the peculiar nature of the bone, the pathologic process in the vast majority of cases has a tendency to (a) spontaneous cure, while about 15 per cent end in (b) abscess formation, many cases of which to-day are saved by well-directed treatment, while a very few, approximately 5 per cent continue throughout as (c) invasive forms of thrombophlebitis and are uniformly fatal.

Each variety of petro-apicitis requires clinical differentiation because the specific line of treatment to be adopted depends not only on the nature of this lesion but on its anatomic position in the bone. The petrous apex, from a pathologic and surgical standpoint is divisible into three domains: (1) The marrow-filled osseous matrix itself, with its dural coverings on its anterior and posterior surfaces; (2) The domain of the carotid canal which passing through the petrous apex contains the carotid artery surrounded by its carotid venous plexus; and (3) the inferior "cribriform" perforated plate on the pharyngeal surface of the apex.

The clinical and surgical aspects are discussed in detail.

CHARLES G. SUTHERLAND, M.B. (Tor.)

THE PANCREAS

The Problem of Cancer of the Pancreas Howard M. Clute Jour Am Med Assn July 11 1936, 107, 91-97

Cancer of the pancreas is by no means a rare disease. It would be safe to assume that 3 per cent of all cancer deaths arise from cancer of the pancreas and total 4,000 a year in the United States.

The malignant process may originate in the parenchyma of the gland in the pancreatic ducts or rarely in the islands of Langerhans. The most frequent type of tumor is the adenocarcinoma, although scirrhous forms are not infrequent. Most pancreatic tumors are primary in the pancreas but a very few are primary

in the biliary tract or duodenum and invade the pancreas secondarily. The tumor is most frequently located in the head of the gland.

In every patient thorough gastro-intestinal x-ray study should be done to rule out lesions in the stomach, duodenum, gall bladder, or colon. A wide sweep of the duodenum around the head of the pancreas may be noted or the greater curvature of the stomach may be encroached on by an obviously extra gastric lesion. Engel and Lysholm have attempted to obtain special films of the pancreatic area by first giving the patient an effervescent powder to fill the stomach with gas. They then take lateral and antero-posterior plates and believe they can outline pancreatic tumors in certain cases. Further progress in x-ray technique will aid in earlier diagnosis of these cases.

CHARLES G. SUTHERLAND, M.B. (Tor.)

PAROTITIS

Roentgen Therapy of Post-operative Parotitis Heinz Knüpper and Rudolf Hummel München med Wehnschr, April 24, 1936, pp 679-680

The authors contribute an excellent and rather comprehensive study of a condition which is but meagerly referred to in the roentgen literature. A total of 59 cases was studied, with 21 of these utilized as controls and receiving no roentgen therapy. The authors conclude that the most favorable time for irradiation is immediately one arrives at a diagnosis and at this stage the condition generally can be aborted. In the majority of the cases in the late stages of the disease, surgical incision was necessary in conjunction with irradiation. Thus 24 of 26 cases which were irradiated from the first day of the onset of the condition required no further treatment, in contrast were 10 of 17 cases in the later stages, which required incisions. In the non-irradiated control group, 10 of 15 required surgical intervention and of these six died. In early cases the parotitis is aborted and, if more advanced there is more rapid softening with ensuing suppuration with the aid of x-radiation. Pain is alleviated and fever is abated. An important consideration is the shortening of the period of hospitalization in those cases irradiated.

In the majority of cases a dose of from 150 to 200 r is administered, employing the following physical factors: 190 kv, 35 ma, 0.5 mm Cu and 30 mm Al filtration (STD not given). This may be repeated in two days if necessary and, in refractory cases, three doses may be indicated.

WILLIAM R. STECHER, M.D.

PEPTIC ULCER

Further Observations on Roentgen Therapy in Peptic Ulcer of the Stomach and Intestines Treated According to Our Method M. Nemenow and A. Jugenburg Strahlentherapie 1936 57, 327

During the period 1934-1936 the authors observed

ROENTGEN SICKNESS

Liver Extract as a Remedy for Roentgen Sickness
Barton R Young *Am Jour Roentgenol and Rad Ther*, May, 1936, 35, 681-688

Liver therapy should be used routinely for roentgen sickness. In 30 cases in which it was employed, complete relief of the nausea and vomiting occurred in 53 per cent, while 23 per cent showed definite decrease of symptoms, and 23 per cent were failures. No harmful effects have been noted. Roentgen intoxication is also benefited.

Two c.c. of liver extract are injected daily, either intramuscularly or intravenously, either just before or shortly after the treatment. The response may be prompt or gradual.

S M ATKINS, M D

SILICOSIS

Diagnosis of Silicosis, with Special Reference to Roentgenological Manifestations
L U Gardner *Ann Int Med*, August, 1936, 10, 166-173 (Reprinted by permission from *British Med Jour*, Nov 28, 1936, p 87 of *Epitome of Current Medical Literature*)

The author thinks that even in the presence of a history of exposure to dust a diagnosis of silicosis should not be made until generalized discrete nodular shadows are seen on the radiograph of the lungs. Large localized shadows suggest complicating infection, but there is also a conglomerate type of silicosis that occurs in the absence of active infection. It may, of course, result from pulmonary damage by a previous infection that has healed. It can be differentiated from active infection only by careful clinical study and by repeated radiographic examinations to exclude change in the character and size of the lesions. The silicotic lung may exhibit the usual manifestations of tuberculosis superimposed upon a background of generalized nodulation, more common are the massive foci of consolidation due to silico-tuberculosis. These may be situated in the upper parts of the lung, where they result from reactivated apical tuberculous foci but often they occur in the middle and lower zones of the lung. They are the result of a combination of very chronic tuberculosis and silicosis progressing simultaneously in the same area. They give rise to much less pronounced symptoms of intoxication than tuberculosis alone. More acute forms of tuberculosis, aspiration disease and military tuberculosis occur, but they are not common. Non siliceous dusts are generally responsible for an accentuation of the linear markings of the lungs. As far as is known, the slight perilymphatic reactions responsible for them do not interfere with pulmonary function and they do not alter the individual susceptibility to tuberculosis.

Asbestosis is not so well understood. The radiograph shows a diffuse haziness of the lower lung fields, and later a very fine uniform stippling. Whether the chronic pleurisy, the increased linear markings, and the conglomerate shadows are due to dust or to the

secondary changes incident to collapse of lobules or to complicating infection has not been definitely settled. The appearance of a tuberculous lesion in the asbestosis lung is apparently not modified. There may be some tendency toward chronicity.

THE SKIN

The Keloid and its Cure by Radiation Therapy
A Hintze *Strahlentherapie*, 1936, 57, 224

The author treated keloids with roentgen rays and radium and found that they were both effective. Severe reactions should be avoided. In comparing the end-results, he found that the normal consistency of the skin reappears with more certainty if radium is used. The skin in the treated areas is also more pliable. A number of illustrations of successfully treated cases are appended. His report is based on 26 patients observed in his clinic during the last 14 years.

ERNST A POHLE, M D, Ph D

Studies of the Permeability of Membranes of Human Skin and its Relation to the Effect of Roentgen Rays on Living Tissue
L Neu and V Neu *Strahlentherapie*, 1936, 56, 692

The authors determined the electric conductivity of the skin of the forearm for a period of 12 days. Then they exposed the volar side of the right arm to roentgen rays (150 kv, 30 cm FSD, no filter, 72 r per minute, doses varying from 4 to 8 minutes). They found that the permeability of the cell membrane may be increased after roentgen exposure and particularly in cases in which the membrane equilibrium is unstable before the irradiation. They conclude from these experiments that tissue with labile cell membranes has an increased radiosensitivity.

ERNST A POHLE, M D, Ph D

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The Differential Diagnosis between Infection and Malignancy in Cases of Dorsal Paravertebral Mass
Walter W Fray *Am Jour Roentgenol and Rad Ther*, May, 1936, 35, 591-603

Three cases of malignant tumors of the spine are described and their differentiating features from masses produced by tuberculous and non tuberculous infections and benign growths.

The important features of malignancy are as follows: (1) preservation of the articular plates in the presence of collapse of the body, (2) slight or no narrowing of disc spaces in cases of marked collapse, (3) absence of wedging, (4) diffuse increase in bone density and involvement of the appendages of the vertebra.

S M ATKINS, M D

THE STOMACH

Lymphoblastoma of the Stomach. Report of Case, with Especial Reference to the Gastroscopic Appearance.

angiomatous mass, and left for some hours. The irradiations cause an obliterating arteritis, the dilated vessels become obliterated, and the angioma disappears. As the reaction occurs in the middle of the nevus the skin is unaffected, and a disfiguring radiodermatitis does not result, as in external applications of radium. Tuberous prominences are often present in angioma planus, and these respond well to radium puncture. This treatment is not completely successful in every case, but improvement always occurs. To be successful, the essential need of early treatment (during the first year of life) is emphasized. An illustrative case is recorded.

The Radium Safe of the Portuguese Institute for Oncology. F Bénard Guedes. *Strahlentherapie*, 1936, 57, 181.

The author briefly describes a special safe constructed for the storing of radium. It offers ample protection to those handling the radium applications. Two sketches are appended.

ERNST A. POHLE, M.D., Ph.D.

ROENTGEN-RAY BURNS AND INJURIES

Experience as to the Tolerance for Roentgen Rays and its Application in the Prevention of Injuries. H. Holthusen. *Strahlentherapie*, 1936, 57, 254.

The author studied the injuries to normal tissue appearing after exposure to large doses of roentgen rays and radium. Using the Coutard method, the percentage of telangiectasis increased from 10 per cent for total doses of from 2,500 to 3,000 r, up to 100 per cent for total doses of 5,000 r and more. In a table the number of cases of telangiectasis and induration of the skin for high doses of roentgen rays and radium in relation to the number of fields are compiled. To day thorough tumor irradiation does not exclude late injuries with certainty, but further improvements in our technic will probably reduce the percentage.

ERNST A. POHLE, M.D., Ph.D.

Chronic Roentgen Injury of the Toes, Dorsum of the Foot and Anterior Lower Thigh in a Radiologist. A. Köhler and W. Brock. *Strahlentherapie*, 1936, 57, 49.

The authors, a radiologist and a dermatologist, describe chronic changes occurring in the toes, dorsum of the foot and lower leg of the former. The changes in the thigh were those of atrophy seen and described in other parts of the body following exposure to small doses of roentgen rays over a long period. Most striking were the changes in the nails of the first and second toe—one seemed to be entirely destroyed but there was no inflammation. The nail itself was of a dark brown color and thickened to about 7 mm; the nail bed was not exposed at any place. This type of change has not been described so far in the literature.

While writing the article the authors received a communication from another radiologist, 50 years of age,

who after 25 years of practice in radiology noticed reactions similar to those described in the article.

ERNST A. POHLE, M.D., Ph.D.

The Danger of Radiation Injuries. R. du Mesnil de Rochemont. *Strahlentherapie*, 1936, 56, 671.

After an analysis of our present knowledge regarding the tolerance of the skin to roentgen rays as applied to the various customary methods (single, massive, fractional, protracted fractional, saturation), the author reports five cases of late injuries. He concludes that in spite of our accurate physical measurements of the dose which render radiation therapy in skilled hands quite safe, there still remains the danger of injury because of our limited knowledge of the recovery periods of normal tissue.

ERNST A. POHLE, M.D., Ph.D.

Intra-uterine Fetal Injuries. H. Naujoks. *München med. Wchnschr.* June 26, 1936, 83, 1039-1044.

An exhaustive review of the etiology of fetal injuries is presented and a rather brief allusion to the role of radiotherapy, both radium and x-rays, is made. The author makes a distinct division regarding the potential ultimate damage that might ensue to the fetus, when a non-pregnant woman is irradiated; the effects being cumulative in the ovaries and the direct effect upon the growing fetus during gestation. The former question is still indecisively settled, there being opinions for and against its possibility and frequency. However, in regards to the latter, there is incontrovertible evidence showing the dire consequences that have followed injudicious radiotherapy.

The author has observed cases in which the fetus showed generalized deficient growth, mental retardation and development of microcephaly and idiocy as well as sundry other changes such as ocular disturbances, changes in the blood picture, etc. In one example, normal first and third children were delivered but the second child was a dwarfed microcephalic later showing paralytic changes and idiocy. This fetus had received irradiation inadvertently during its early formation, i.e., during the first three months of intra-uterine life. The author strongly urges the detection of early pregnancy in cases in need of deep radiotherapy and the proper treatment of these patients before irradiation is administered.

WILLIAM R. STECHER, M.D.

Radiation Injuries Following Treatment of Skin Tuberculosis. W. Schultze. *Strahlentherapie*, 1936, 57, 165.

Roentgen rays must be used cautiously in the treatment of tuberculosis of the skin. The author saw 17 cases with roentgen injuries in a relatively short period. Even Grenz rays may be responsible for late reactions. A series of photographs is appended to the article demonstrating the lesions.

ERNST A. POHLE, M.D., Ph.D.

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S M ATKINS, M D

THE STOMACH

Lymphoblastoma of the Stomach. Report of Case, with Especial Reference to the Gastroscopic Appear-

ance John F Renshaw Jour Am Med Assn, Aug 8, 1936, 107, 426-428

This is a report of a case with especial reference to the gastroscopic appearance. The roentgenologic examination of the stomach revealed markedly enlarged rugae which could not be obliterated by pressure. This was interpreted as due to a marked submucosal infiltration which had not broken through the mucosa, from the x-ray examination alone it was not possible to differentiate definitely between a marked hypertrophic gastritis, a submucosal infiltrating carcinoma and, in view of the biopsy an infiltrating lymphoblastoma.

The gastroscopic findings were similar to those reported in the other two cases observed gastroscopically and reported. In these two there was a diffuse infiltrating process involving the whole stomach. In the author's case the process was circumscribed. Without knowledge of the cervical biopsy and the response to radiation therapy, the diagnosis of lymphoblastoma of the stomach would not have been made.

Schindler believes that the appearance of the diffuse infiltrating process is characteristic and cannot be mistaken for anything else. In contrast to the diffuse type, the circumscribed lymphoblastoma is less characteristic.

CHARLES G SUTHERLAND M B (Tor)

The Roentgenologic Appearance of the Resected Stomach Giovanni Baldelli Arch di Radiologia 1936, 12, 9-41

In this study Baldelli illustrates and discusses the physiology and mechanics of the stomach after resection. Because of the detailed extent of his findings it is suggested that the paper be consulted in the original.

E T LEDDY M D

SYPHILIS

Contribution to the Etiology of Cancer R Gassul Strahlentherapie, 1936, 57, 20

After a general discussion of the various theories regarding the etiology of cancer, the author relates the history of a male patient, 33 years of age who entered the clinic with an ulcer of the penis and glandular swelling in the right groin. At the age of 19 he had had typhoid fever, at 24 years syphilis and at 29, malaria. Microscopic examination after admission to the clinic showed the presence of *Streptobacillus Ducrey* Unna. The Wassermann reaction was negative. Local treatment brought about healing of the ulcers. In the glands of the right groin fluctuation developed, treatment was by incision and drainage. The wound showed very little tendency to heal and within a few months developed into a large ulcer 11 x 4 cm and 4 cm deep. A biopsy, taken from the margins showed carcinoma. A course of x ray therapy was given but not completed because the patient left the hospital. He was brought in three months later because of hemorrhage from the ulcer and it appeared that the carcinoma had eroded the large vessels of the thigh. The patient died within a few hours after admission.

From this observation the author concludes that it is advisable to take biopsies in cases of inflammatory disease accompanied by ulceration and proliferation of tissue. Particularly in the case of a chancre, the possibility of a developing malignancy should be considered.

ERNST A POHLE M D, Ph D

THE TEETH

Changes in Teeth Following Protracted Fractional Roentgen Therapy M Lüdin and O Muller Strahlentherapie 1936 56, 644

Roentgen injuries of the adult tooth have been reported so far in only two instances, the authors add to these one case of their own. It occurred in a male 45 years old, who received 40 sittings over three fields during four weeks according to the Coutard method and a total of 6,990 r. Three months after the treatment the crowns of the teeth located within the treated area became soft, showed brown discoloration, and developed defects in the enamel. Histologic examination of the extracted teeth showed definite changes in the pulp and periodontium. Since no other explanation for these peculiar changes could be found the authors assume that they were due to the exposure to roentgen rays. They conclude that in cases of this type the teeth should be shielded by adequate protective materials.

ERNST A POHLE, M D Ph D

THE THYMUS

The Radiotherapy of Thymic Hypertrophy Enrico Benassi Archivio di Radiologia, 1936, 12, 65-69

The author reports 'brilliant results' by the use of a cycle of five treatments given every two days with from 80 to 120 r through an anterior thoracic field 6 x 8 cm with 150 kv, 2-4 ma, 30 cm TSD, and filtration of 0.3 mm zinc + 3 mm Al. This is repeated in from six to eight weeks. This technic may be modified as occasion requires. (The author does not state the number of cases he has treated.)

E T LEDDY M D

Primary Carcinoma of the Thymus Gland Case Report H A Slesinger Jour Lab and Clin Med November 1936 22, 151-155

The rarity of carcinoma of the thymus gland is indicated by the fact that, including the author's patient only 53 cases have been reported. The clinical picture of all thymic tumors is the same. There is nothing to distinguish a carcinoma from a lymphosarcoma clinically except the response of the latter to radiotherapy. Symptoms are those of pressure in the upper portion of the mediastinum. Exophthalmos is frequently encountered. X-ray examination shows a tumor which is located in the upper portion of the anterior mediastinum. Symptoms usually appear late, often not until a few weeks or months before death. Treatment is unsatisfactory. Carcinoma of the thymus gland is not radiosensitive.

W A SODEMAN M D

TUBERCULOSIS

Pathogenesis of Tuberculosis Max Pinner Jour Am Med Assn, Aug 15 1936 107, 475-477

The first infection is, in the vast majority, by inhalation and the first focalization is in the pulmonary parenchyma. As far as the bacillus is concerned the pathologically most important characteristics are its high resistance, its singularly complete adaptation to parasitic life, its relative virulence, the dosage of infection and its chemical constituents which stimulate or alter more or less specifically different tissue elements. The first infection causes two potentially permanent alterations in the host: it produces allergy and it establishes within the body a deposit of tubercle bacilli.

The reality of endogenous reinfection is proved beyond doubt by the frequent occurrence of foci in localizations that could not possibly be reached by direct exogenous reinfection such as the skeletal system, the urogenital tract, or the brain. The immunologic change that is brought about in man by a first infection is as a rule not manifested by a complete resistance to exogenous reinfection but by the much greater tendency in infected beings to a stricter localization of the lesion and by a greater tendency toward productive and fibrotic lesions. The first focalization of bacilli occurs as a rule in the parenchyma of the subpleural layers of the lung, relatively rarely in the apex. The earliest lesion is a tuberculous pneumonia which soon becomes surrounded by proliferative tissue changes from which a dense fibrotic capsule develops around the center which in turn undergoes caseation and calcification. Simultaneously or somewhat later the mediastinal lymph nodes become involved through lymphatic transport of bacilli; they undergo rapid caseation and then show more or less completely the same retrogressive changes as does the parenchymal lesion. The most frequent development of this primary complex, consisting of a parenchymal and lymphoglandular focus, is retrogression without clinical disease, leaving the unmistakable pathologic marks of a well demarcated parenchymal calcified focus and frequently multiple calcifications in the mediastinal lymph nodes. In this stage the tuberculous infection may remain and does remain in the majority of all infected persons, a scar as it were, with which allergy caused by the infection is then the only mark left. In some cases the parenchymal focus may progress by contiguous spread, causing extensive caseous pneumonias and excavations. More frequently the parenchymal focus heals while the lymphoglandular focus smolders on for greatly varying periods, at intervals discharging bacilli into the lymph and blood stream. The bacilli may focalize anywhere in the body, causing bone lesions, urogenital disease, scattered lobular pneumonic foci (usually in the upper portions of the lungs) or if a massive discharge of bacilli from a liquefied caseous lymph node occurs, the result may be a generalized miliary tuberculosis.

The so-called secondary stage may never occur, or again it may manifest itself at any later stage of the dis-

ease. Pulmonary lesions similar to those seen during childhood in the phase of early dissemination are sometimes seen in adults. It is likely that the majority result from lymphohematogenous spread from primary lymph node foci. The pulmonary foci—true hematogenous tuberculosis—are symmetrically seeded throughout both lungs. Not infrequently they heal clinically by resorption, fibrosis, or calcification, others excavate and then continue the usual course of bronchogenic phthisis. Following the more or less complete healing of the primary complex or subsequent to major or lesser manifestations of early dissemination, a latent period usually intervenes before tuberculosis in the adult develops. In many cases of early dissemination no further clinical manifestations occur.

The typical pulmonary tuberculosis of adult life begins in most cases with a single, initially exudative focus. There are essentially three mechanisms by which this clinically primary focus may develop: (1) A bronchogenic spread occurs from incompletely healed apical lesions, the remnants of foci produced by early dissemination. (2) Bacilli from a still active primary lymph node focus are discharged into the lymph stream, are carried into the blood stream, and are filtered out in the lung. (3) Bacilli are inhaled from the outside. Regardless of the mechanism by which the new focalization takes place, the early lesion is a tuberculous lobular pneumonia which is seen most frequently in the subapical region. This lesion is always unstable, it soon progresses or retrogresses. Demonstrable involvement of the regional lymph nodes practically never occurs. This exudative focus, the so-called Assman focus, or early infiltrate or infraclavicular infiltrate, again is subject to all the potential developments: resorption, fibrosis, caseation, liquefaction, excavation. If a cavity develops, a frank and perilous source of bacillary dissemination is established, from which at any time new bronchogenic spread may occur. From this point on, bacillary propagation through preformed channels, and localized destructive lesions constitute the main character of the disease. Within the lung this means bronchogenic spread and beyond its boundary it means ulcerative tuberculosis of the larynx and the intestine.

CHARLES G. SUTHERLAND, M.B. (Tor.)

Tuberculosis of the Clavicle. Review of the Literature and Report of a Case. Jacob Sirlin and E. A. Baumgartner. Jour Am Med Assn. July 11 1936 107, 120-123.

The authors were able to find record of 30 cases in the literature. Most of the patients were between 10 and 40 years of age, only four of them being over 50 years of age. The disease is about equally frequent in the two sexes. There was no apparent predilection for either clavicle. There appears to be no anatomic or pathologic reason why primary involvement of the clavicle cannot occur. Other co-existing foci of tuberculosis were described in eleven cases, bone involvement in four, in the others the lungs, glands,

of the neck, kidney, and breast showed tuberculous lesions. The patient whose case they report had a tuberculous kidney successfully removed some time before and x-ray examination showed a lesion of the sacro-iliac joint with the characteristics of a tuberculosis.

CHARLES G. SUTHERLAND, M B (Tor)

TULAREMIC PNEUMONIA

Tularemic Pneumonia LeRoy H Sloan A S Freedberg, and J C Ehrlich Jour Am Med Assn, July 11, 1936, 107, 117-119

Tularemia is a relatively newly described disease in the medical literature. In 1924 Verbruycke first made mention of a pneumonic process specific for this disease in the report of a fatal case with the necropsy findings. The first mention of tularemic pneumonia as a clinical entity appeared in 1931, when three separate cases were reported in the literature. Only one instance of recovery of the organism from the sputum was recorded. The frequent association of caseous pneumonia with tularemia makes it reasonable to assume that an atypical pneumonia developing in a patient with a clinical history of tularemia, particularly if associated with pleural effusion, the pneumonia running a protracted course and the failure to establish tuberculosis or other specific granulomas as the causative factor ought to be sufficient evidence to establish the clinical diagnosis of tularemic pneumonia. The physical and x-ray signs of pulmonary consolidation appear quite late in the course of the disease and do not disappear until long after apparent clinical recovery if at all. The process evidently begins with involvement of the hilus, which then spreads peripherally. The authors report a case in which recovery was complicated by a spontaneous pneumothorax.

CHARLES G. SUTHERLAND, M B (Tor)

TUMORS (DIAGNOSIS)

Neuroblastoma from the Standpoint of the Roentgenologist E L Rypins Ill Med Jour November 1936 70, 431-436

Rypins reports three children aged 4, 4 and 5 years, with proptosis, hydrocephalus, marked secondary anemia with destructive and proliferative lesions involving the greater portion of the skeletal system including both the long and the flat bones. No abdominal tumors were palpable. X-ray examinations showed the presence of a peculiar type of periosteal reaction or "whiskers" along the left ischium in one patient and along the lower end of both femora in another. When occurring in the skull this periosteal reaction is said to give a porcupine appearance. These changes in conjunction with the widespread destructive process Rypins considers sufficient for a definite diagnosis of neuroblastoma. Pathologic diagnosis may be difficult especially in the absence of cell arrangements known as rosettes. The tumors are sensitive to irradiation

if treated while the patient is still in a relatively good condition. All three cases reported by the author, however, died.

W A SODEMAN M D

TUMORS (THERAPY)

Radiotherapy for Primary Malignant Tumors of Bone Ettore De Bernardi Archivio di Radiologia, 1936, 12, 42-48

The author reports four cases of bone tumor, three of which were treated with x-rays with satisfactory results. He feels that radiotherapy is the method of choice in the treatment of these tumors.

E T LEDDY M D

Roentgen Therapeutic Results in Bone Tumors G Schulte Strahlentherapie, 1936 57, 370

The author reports a number of cases with bone tumors in which protracted fractional roentgen therapy has been of benefit. As a therapeutic test it was also helpful. The cases reported include a multiple osteohemangioma, osteo-epulis of the mandible, chondroma of the shoulder and hip, multiple myeloma and Ewing's sarcoma.

ERNST A. POHLE M D, Ph D

Malignant Bone Tumors Cured by Radiation Therapy A U Desjardins Strahlentherapie, 1936 56, 583

The author describes the use of his technique of "convergent" fields in the treatment of malignant bone tumors. Fairly high doses can be delivered to the neoplasm in this manner without danger to the skin. Three illustrative case reports are appended.

ERNST A. POHLE M D, Ph D

UNCLASSIFIED¹

The New Institute of Radiology and Biophysics in Istanbul Friedrich Dessauer Strahlentherapie 1936 56, 389-395

This is a brief description of the radiological institute which the author is developing at the University of Istanbul in Turkey. It offers complete facilities for teaching and research; there are also wards in which to hospitalize patients with malignant disease while under treatment.

ERNST A. POHLE M D, Ph D

Physics and Radiology J A Crowther British Jour Radiol December 1936 9, 767-775

In an expression of appreciation of the honor conferred upon him by his election, the President of the British Institute of Radiology traced the relationship

¹ The abstracts under this heading are of undoubted interest yet they do not fall under any single grouping. It has been thought best to let our readers have access to them under this heading.

of physics to radiology Physics and medicine have been more closely associated in the past than is generally realized, for every physical discovery of any importance has been followed by an attempt to apply it therapeutically The discoveries of magnetism, electromagnetic induction, and of radium and the α rays are well-known examples

The contributions of medical men to the science of physics should not be forgotten. We owe the discovery of magnetism and the name of 'electricity' to the Colchester physician, Sir William Gilbert Galvani was a Professor of Obstetrics and not of Physics Dr Thomas Young contributed valuable fundamental information of the wave theory of light, and of other subjects of physics in his studies which were pursued with the object of making them subservient to the practice of medicine. Until recent times the contributions of physicists to the art of medicine were not so notable although Robert Boyle was responsible for the employment of plaster of Paris and of gelatine for anatomical injections

The first great contribution of physics to medical science were the discoveries of α -rays and radio-activity, by Thomson Röntgen Becquerel, and Curie in 1895 and 1896 X-rays differ in many respects from a new drug or serum While the dosage of the drug can be dispensed by counting tablets or by weighing and the dosage of vaccine or serum can be determined in the physiological laboratory, the α rays must be measured at the time they are produced

Many problems regarding the dosage of α rays have yet to be solved The association of soft rays medium rays and hard rays in the same beam, the production of rays which may vary from 60 kv p or less to 600 kv p or more, the relationship of rays of relatively long wave length expressed in roentgens with a similar dose in roentgens of rays of short wave length the action of α rays on the individual cell or on the colloids of the organism are examples of the problems which emphasize the importance of the close co-operation of physics physiology, and chemistry The progress in refinement of apparatus has been considerable and the gap between modern α ray equipment and primitive outfits is greater than the jagged flint used by the prehistoric surgeon in his operations and the modern surgeon's scalpel The advance through constant improvement from the old gas tube and the adoption of a scientific unit for measuring the output of radiation have been significant in modern therapeutic roentgenology

In radiography much is expected from cine radiography in the future Dr Russell Reynolds while not a physicist should be congratulated on excellent experimental research in the development of this method

Dr Strangeways well known original experiment on the irradiation of tissue cells has been extended and amplified by Dr Maynard in a brilliant piece of mathematical deduction

While the strict division of the total of human knowledge into numerous distinctly separate sciences has served many useful purposes in the past the partitions

are growing thin There are many problems and that of the action of radiation on the cell seems to be one of them, where a joint attack promises the best hope of success

That radiology is a science of many ramifications is fully appreciated by all, and the necessity for the organization of the British Association of Radiologists as recently set forth by the President of that new organization is recognized With the necessary good will, the close co-operation of the British Institute of Radiology and the new British Association of Radiologists should do much for the advancement of physics and radiology

J N ANÉ, M D

The New Roentgen and Radium Institute in Aarhus, Denmark Carl Krebs Strahlentherapie 1936, 56, 456-465

The new Roentgen and Radium Institute erected recently in Aarhus Denmark is described by the author Photographs of the building floor plans, and a description of the apparatus used are appended

ERNST A POHLE, M D, Ph D

Wilson Photographs of Roentgen Rays Passing through Matter L Grebe Strahlentherapie, 1936, 56, 603

The author demonstrates six Wilson photographs taken in the 'cloud chamber' showing the path of electrons after passage of the α ray beam through air air-equivalent material, and gold The long path of the photo-electrons as well as the short path of the recoil electrons are shown in the illustrations

ERNST A POHLE M D Ph D

The Morphologic Relationships between the Heart and the Stomach in Proportion to the Constitution of Fifty Soldiers as Shown by Radiologic Studies Luigi Sammola Archivio di Radiologia 1935 11, 379-396

The soldiers in this study were grouped according to Viola's classification and were studied by orthodiagram Sammola's findings in regard to the size and shape of the heart and stomach agree with those of other authors and he points out the various similarities and differences he found with respect to the body type of the individual

E T LEDDY, M D

Concerning Bridges between the Clinoid Processes Technical Demonstration of Clinoid Processes and of Clinoid Bridges Ludwig Haas Fortschr a d Geb d Röntgenstrahlen February 1935 51, 147-152

This is in reality two short papers one stating that osseous bridges between the anterior middle and posterior clinoid processes are normal variations and have for instance no relationship to bronchial asthma as maintained by Bien the second illustrating beautifully that detailed views of the clinoid processes of the

side close to the film may be obtained by limited tube shifting in either the vertical or caudal direction, from the point of typical centering and aiming at the sella itself instead of its point of projection to the temporal surface—at an angle of about 15 degrees in either vertical or caudal direction

H A JARRE, M D

THE UTERUS

External Irradiation with Roentgen Rays of 200 and 300 Kv as Initial Treatment in Carcinoma of the Cervix M R Mathey-Cornat *Strahlentherapie*, 1936 57, 313

The author believes that in the treatment of carcinoma of the cervix it is preferable to use roentgen rays externally first, before applying radium intra uterine. Technic 200 kv, 2 mm Cu + 2 mm Al, 5–10 r per minute, 40–60 cm FSD, 4–6 fields of 15×15 or 15×20 sq cm, 3,000 r per area and 3,000 to 3,500 r effective in the vagina. When 300 kv are used the depth dose is still better, at the same time sparing the skin from excessive doses. In the more advanced cases this preliminary roentgen therapy often renders the cervical canal patent.

In the author's experience this desirable effect was obtained in from 48 to 49 per cent of the early and borderline cases and in from 40 to 41 per cent of the advanced cases. He also has the impression that intra uterine radium treatment is tolerated better if x-ray therapy has preceded it. Hospitalization of the patient during this combined x ray and radium treatment is necessary.

ERNST A POHLE, M D Ph D

Are the Operative Results in Carcinoma of the Cervix Improved by Post-operative Irradiation? H R Schinz *Strahlentherapie* 1936 57, 393

The author studied the statistics published in the world literature regarding the percentage of cures in patients with carcinoma of the cervix treated by operation alone or by operation plus irradiation. After a critical analysis of the available figures and the calculation of the mean error he comes to the conclusion that the combined treatment is at least 7 per cent (theoretical calculation) or 3.3 per cent (empirical calculation) superior to operation alone.

ERNST A POHLE M D Ph D

XANTHOMATOSIS

Xanthomatosis (Schüller Christian's Disease) Robert A Strong *Jour Am Med Assn*, Aug 8 1936 107, 422–425

This term is used to describe a syndrome of certain bony defects in the skull, diabetes insipidus and exophthalmos. Hand presented the first case in 1893, believing it due to tuberculosis. Schüller reported two cases in 1915 and felt that the skeletal defects were secondary to disease of the hypophysis cerebri. Christian reported a case in 1919 and considered that the syndrome was due to a pituitary disturbance. It has since been established that the bony defects are predominantly the initial symptom. Rowland (1928) reviewed the literature extensively, presented two cases of his own, and was the first to prove that Schüller Christian's disease belonged in the same class with all the other diseases due to defective lipid metabolism. He suggested the name "xanthomatosis."

Five clinical entities have been included under the general heading of xanthomatosis by several writers. They are Gaucher's disease, Niemann-Pick's disease, Schüller Christian's disease, the xanthomas occurring in icterus, diabetes and pregnancy and the so-called essential xanthomatosis.

The etiology is unknown, the etiologic factor common to all apparently being a disturbance of lipid metabolism or of lipid excretion resulting in the storage of various forms of lipid material in the organs or tissues of the patient. They may be either widespread and diffuse (as in Niemann-Pick's and Gaucher's disease) or localized in granulomatous deposits, as in Schüller Christian's syndrome and the cutaneous xanthomas. The xanthoma cell is a cell of reticulo-endothelial origin infiltrated with lipoids and the reticulo-endothelial system is said either to remove an excess of lipoids from the tissues or to store an excess in areas in which trauma or infections may have stimulated a collection of histiocytes.

The most hopeful treatment for this condition is through diet and roentgen therapy applied to the areas of lipid deposit. This apparently benefits the bone defects but does not improve the exophthalmos.

In the discussion Wahl pointed out that in Gaucher's disease the lipid is a cerasin, in Niemann-Pick's disease it is a lecithin while in Schüller Christian's disease it is a cholesterol compound.

CHARLES G SUTHERLAND M B (Tor)

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ERRORS IN X-RAY DIAGNOSIS OF INDUSTRIAL INJURIES

By W. WARNER WATKINS, M.D., F.A.C.R., Pathological Laboratory, Phoenix, Arizona

THIS paper and the exhibit accompanying it are not presented with the idea of bringing anything new by way of technic or interpretation to the roentgenologist. That would be impertinent, because the illustrations come out of the very kindergarten of diagnostic roentgenology. Commonplace as they are, however, these errors can be useful if they help us to sense more keenly some dangers which beset our special field of work, and make us more determined to insist on fundamental principles in the practice of x-ray diagnosis.

If, by imagination, we can picture diagnostic roentgenology as an organism, subject to forces which can help it or injure it, as all organisms are, let us consider certain elements of a malignant chronic disease which afflicts us. This ailment is not new and has been treated by many palliatives, but like other insidious malignant conditions which concern us as radiotherapists, whenever we succeed in stopping its advance in one direction, it crops up in a new form and place. We will call this disease "pseudo-roentgenology" and will briefly consider its causes, symptoms, and treatment.

There are three causes which spring from a common stalk of normal development, that is, the laudable desire to make the greatest possible use of the most valuable single aid we have in the diagnosis and treatment of human ailments, namely,

x-ray. From this normal stalk have sprouted three lines of activity which have become parasitic and now threaten the very life of the organism on which they have grown.

1. The widespread distribution, by energetic manufacturers, of small and inexpensive x-ray plants. In the development of small x-ray units, the slogan of the manufacturers might well be "an x-ray machine in every doctor's office," and is being enlarged to include the office of every irregular practitioner who can legally operate one. A doctor can hardly get his sign on the door, in any hamlet in the United States, and his name in a telephone directory, before some high pressure salesman is importuning him to boost his practice by doing his own x-ray work. "Why pay the radiologist on the next floor or in the next block to make your x-ray pictures? Your office girl, in forty-eight hours, can learn to make perfectly satisfactory x-ray films which you can easily interpret yourself, you can then do your own industrial x-ray work, set fractures under the fluoroscope, examine the hearts, chests, and stomachs of your patients, make a great impression and pay for your equipment inside of a year." Is that an overdrawn statement of what occurs? If it has not been done repeatedly in your own community, you have been overlooked and have, so far, been fortunate. Six definite instances could be cited in which statements even more presumptuous than this

¹ Presented before the Radiological Society of North America at the Twenty-second Annual Meeting, at Cincinnati, Nov. 30-Dec. 4, 1936.

have prefaced the sales of x-ray equipment in a community of fewer than 100,000 people, each of these to be operated by general practitioners who were to make their own interpretations. A most astounding instance of high pressure salesmanship was that in which our Industrial Commission was persuaded to buy an x-ray plant and install it in the office of their medical referee without consulting him and while he was in New York City doing post-graduate work. His successor gave the equipment away, as he needed the room to hold the filing cases of mistakes made by other owners of x-ray equipment.

2 Out of this mistaken idea, created by advertising and propaganda, has developed the next causative factor of the malignant disease of pseudo-roentgenology. Having acquired the equipment, the doctor naturally tries to handle as much of his x-ray work as possible, thinking, in his ingenuousness, that the taking of films of bone injuries and the interpretation of findings is a very simple matter. So, we find many doctors, entirely unfamiliar with the normal appearances of bones and joints on roentgenograms, x-raying their own patients, trying to interpret the films, and basing their reports and management of injuries on these inadequate examinations and frequently incorrect interpretations.

3 The third cause of the disease of pseudo-roentgenology is akin to the other two. It is the still prevalent misconception of the true place and scope of diagnostic roentgenology in the practice of medicine in general. This misconception is well illustrated by a recent decision of the Supreme Court of California which is, in effect, that the practice of diagnosis by x-ray can be indulged in by anyone and does not constitute practice of medicine. The court's decision referred to a chiropractor and stated that he can *not* give colonic irrigations nor diathermy treatments, because these are a part of the practice of medicine, but that he can make x-ray films and interpret them in diagnosis.

If educated jurists have no better conception of roentgenology in relation to

medicine, is it any wonder that the average doctor, notoriously credulous to any sales talk, is easily persuaded that his opinion is as good as that of any roentgenologist on what is shown by x-ray films? The courts accept his opinions and interpretations, so why should he harken to the counsel of the jealous x-ray specialist (who doubtless is only trying to save the work for himself), that roentgenologic interpretation requires expert knowledge, a constantly changing technic, and a profound knowledge of clinical medicine?

What are the symptoms or evidences that such a disease flourishes in the organism of roentgenologic practice? While it pervades every branch of our work, this discussion will be confined to some evidences found in a single narrow field, namely, that of industrial injuries, including automobile accidents covered by personal liability insurance. The symptoms arising out of the causes stated above are represented by errors in diagnosis, due (1) to inadequate and imperfect technic, and (2) to interpretations based on insufficient knowledge and training.

The knowledge of skeletal anatomy acquired in medical schools is not sufficient to become the sole basis of roentgenologic interpretations of injuries to bones and joints. Examples of errors due to inadequate technic are familiar to every roentgenologist, but through a unique system adopted by the medical referee of the Arizona Industrial Commission, an opportunity has been given to see an unusual number of them within the past few years. In spite of strenuous protests from many of the doctors involved, the rule was adopted that all reports on industrial injuries treated throughout the State must be accompanied by any x-ray films taken, whether these were regarded as showing injury or not. This has resulted in the accumulation of a large number of mistaken diagnoses including injuries actually shown by the films taken but not recognized by the surgeons who took them, as well as misinterpretations of shadows. In addition to this accumulation of films which

now fills the room formerly occupied by the white elephant x-ray plant, there is another unique set-up in Arizona. This is the Medical Advisory Council to the Industrial Commission, composed of five doctors appointed by the president of the State medical association, to which group was added a consulting radiologist who is a diplomate of the American Board of Radiology. This Council is entirely unbiased, is placed under no restrictions by the Industrial Commission, being asked to examine the injured workmen referred to them as purely medical or surgical problems. The question of the compensation involved in their decisions is not to be considered by them, unless it has a bearing on the physical condition found. If the Council asks for further time for the injury to become stationary, if they suggest medical or surgical procedures not yet tried, if they desire special examinations which no member of the Council can make, these recommendations are followed by the Commission without question, regardless of cost. If the injury is stationary, a rating of permanent disability is given and this is accepted by the Commission, regardless of the shock to the compensation fund when the rating is high, or the frothing and fuming of the workman and his attorney, when the rating is lower than their demands. Of course, the acceptance of the conclusions of this Council as final, in preference to any amount of opinion testimony, pro or con, from experts hired by one side or the other, has not passed unchallenged by the legal ambulance chasers and a concerted effort is being made to secure the abolishment of this Council. It was even made an issue in our last gubernatorial campaign, and since the candidate for governor who publicly attacked the Council's work was elected, the system may not last much longer. A test case has already gone up to our Supreme Court and the system was not only upheld by their unanimous decision, but was highly commended as the only procedure in vogue which is calculated to arrive at a fair and unbiased conclusion.

The errors found as the result of inadequate technique and inexpert interpretation may be grouped under four heads.

(a) The cases in which perfectly normal structures have been mistaken for abnormalities by surgeons unfamiliar with x-ray appearances. It would probably seem that fellows of the College of Surgeons ought to be able to interpret films of the extremity bones, at least. However, we have seen more errors in the interpretation of conditions in the wrists and feet than we have anywhere else in the body. A case which caused great commotion in our Industrial Commission had reference to a sesamoid bone of the great toe. The foot was x-rayed and diagnosed by a surgeon as showing a "dislocated (*sic*) sesamoid bone" of the great toe¹. The case cost the Commission \$2,500, and when the films were examined by a roentgenologist, he found the bones, including the sesamoids, entirely normal.

In another case the normal sesamoid in the popliteal space was diagnosed as a fragment of bone *inside* the knee joint. Only the insistence by the consulting roentgenologist that the structure was perfectly normal and entirely outside of the joint, prevented an attempt to remove this by surgical procedure.

One who does not recognize the os-peroneum as a normal bone would certainly be classed as a tyro, yet we have seen one reported as a fracture of the cuboid. The mere fact that it was large and irregular in shape did not excuse this error in any one pretending to make x-ray interpretations.

Perfectly normal ununited transverse processes of the first lumbar vertebra (Fig 1) have several times been diagnosed as fractures by industrial surgeons in our experience. The statement in Gray's Anatomy, that this "anomaly is rarely met with" is misleading. During the past three years we have kept watch of all our films showing this area of the spine, and have found the anomaly present in about 5 per cent of adult spines. Two cases of this sort have gone to court with reputable

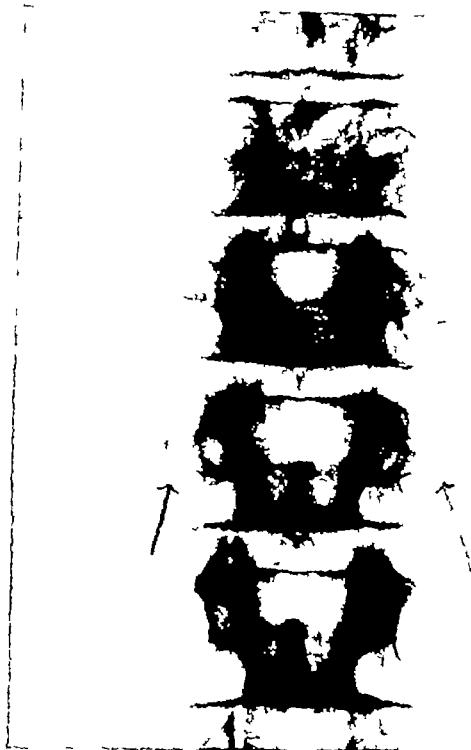


Fig 1



Fig 2

Fig 1 Ununited transverse processes of the first lumbar vertebra, bilateral. Incidental finding with no history of injury. This condition is found on one side or both in approximately one person in twenty.

Fig 2 Unilateral ununited transverse process of first lumbar vertebra, found after a back injury. Case finally went into court and a surgeon with little experience in x-ray interpretation testified that, in his opinion, this was a fracture. Although an experienced roentgenologist and two competent orthopedic surgeons testified that it was a normal condition for this individual, a verdict for \$6,000 damages was awarded. This kind of injustice results from our archaic legal system which permits an uninformed jury to choose the testimony they will accept, regardless of the comparative training and experience of the doctors testifying.

and experienced surgeons testifying that they were fractures (Fig 2)

The os trigonum has been repeatedly mistaken for fracture by surgeons trying to function as x-ray experts (Fig 3). Only the roentgenologist whose eye has become thoroughly trained in an appreciation of bone contour, texture, and density can be trusted to say whether such a detached bone is really an os trigonum or a fractured posterior process of the talus. Repeated experience builds up in the brain of the roentgenologist the ability to become certain through steps which he cannot demonstrate to juries nor even to other medical men whose perceptive abilities are not similarly trained. In the case of the os trigonum, as with other conditions, it is often just as difficult for a roentgenologist

to show *why* he is certain of his opinion, as it is for the expert in precious stones to demonstrate to the untrained eye why he knows a diamond is real and not an excellent counterfeit. We may listen solemnly and nod our heads but, in the end, we must simply take his word that it is so.

The tibiale externum has been a source of error several times in our experience and in at least one instance such a bone has been removed surgically as an ununited fracture, without benefit to the patient.

The free ulnar styloid has several times been mistaken for fracture. When associated with Colles' fracture this error is not important, but when such a bone is the only basis for diagnosis of injury, it becomes serious.

Free bones about the humeral condyles

or beyond the malleoli at the ankle have been mistakenly diagnosed as fractures several times

and their car collided with a truck. The friend claimed a back injury and sued the company owning the truck for \$50,000



Fig 3 An os trigonum which was diagnosed as fracture by an orthopedic surgeon who makes his own x ray interpretations. The case finally had to be adjudicated by the Medical Advisory Board, who decided it was not a fracture

The anomalies found so frequently in the lumbosacral area will be mentioned only to insist that the significance of the conditions found belongs in the realm of roentgenologic interpretation, and the roentgenologist should not yield to the orthopedic surgeon the entire right to say whether or not certain anomalies found are likely to be the cause of the symptoms complained of. The roentgenologist is primarily a clinician and has built his special knowledge on general medicine. In drawing his conclusions, he should use all the clinical knowledge he possesses, as well as his technical skill and experience as an expert in interpretation of x-ray shadows.

A familiar anomaly illustrates what might happen in the automobile liability racket. A man was driving with a friend



Fig 4 An unfused tip of the spinous process of the fifth lumbar vertebra associated with spina bifida occulta of the sacral arch. This condition was found during x-ray examination after an automobile accident and was diagnosed as fracture by a surgeon. This case finally went to court, suing for heavy damages. The jury accepted the unsupported testimony of a roentgenologist that the condition was an anomaly, as against the contentions of three surgeons that it was a fracture and brought in a verdict of "no damages."

The chief evidence of injury, aside from his complaints, was a film showing a condition diagnosed as fracture of the spinous process of the fifth lumbar vertebra (Fig 4), this being the testimony of the man who made the film and three surgeons. The condition shown was not a fracture, but a congenital anomaly associated with spina bifida.

Belonging in this same group are the errors of misinterpreting epiphyseal lines as fractures. This still happens, in spite of all the voluminous literature on the subject, this evidently not being as widely read as it should be. The normal epiphyses which later are going to unite, differ from the anomalous bones mentioned above which remain permanently ununited. In this group, we have seen instances of the following:

The internal humeral epiphysis, which is frequently seen in young workmen (Fig 5)

The tubercle of the fifth metatarsal bone

Prominent tibial tubercles, diagnosed as Osgood-Schlatter's disease

The marginal rim of the ilium, which

cal Advisory Council, the roentgenologist has called for some additional examination or some special technic not previously employed, and some astounding revelations have been uncovered. Perhaps the most

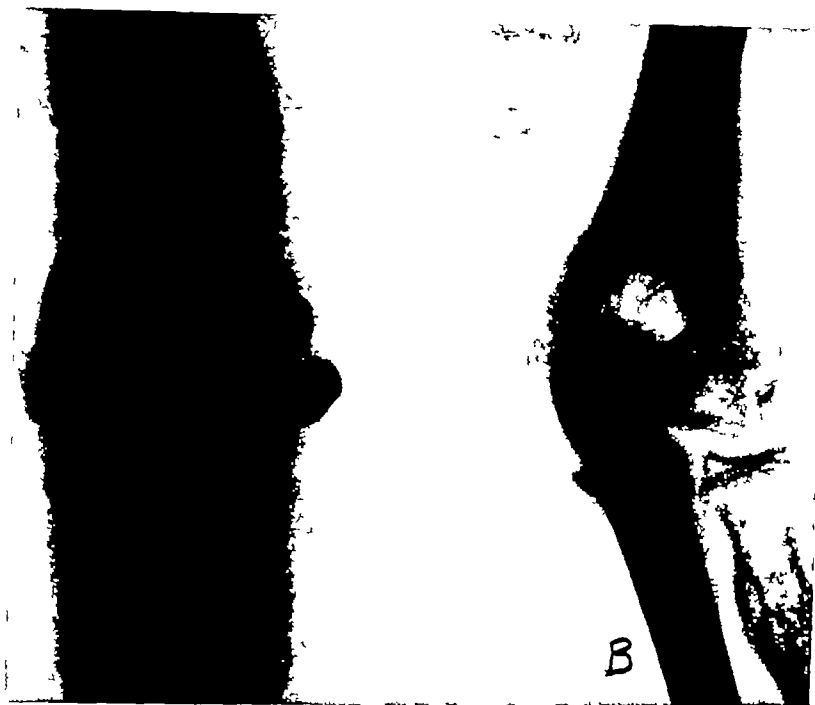


Fig 5 In (A) there is a true fracture of the internal condyle of the humerus with the usual displacement distalward. In (B) fracture of the internal condyle was diagnosed but this opinion was changed by the surgeon when he consulted a roentgenologist who demonstrated under the fluoroscope that the fragment was not movable and not tender over the line of separation.

may develop in several pieces on one side and in a solid piece on the other.

The upper margin of the acetabulum, which may remain unattached as the os acetabuli.

The extremity of the acromion process.

Other transverse processes in the spine beside the first lumbar.

Tips of articular processes in the lumbar spine.

(b) The second group of errors due to inadequate technic are those in which the examination was too limited in scope, or in which inexperience has caused the lesion actually shown to be overlooked. This group will illustrate the danger of trying to separate technical procedures from professional services in hospitals. In practically every case coming before our Medi-

cal Advisory Council, the roentgenologist has called for some additional examination or some special technic not previously employed, and some astounding revelations have been uncovered. Perhaps the most striking illustration of the necessity of combining interpretation with special technical procedures directed by the roentgenologist and basing both of these on a knowledge of the clinical symptoms, was the following case. A policeman got up suddenly out of a swivel chair and stepped on a match which rolled under his foot. He fell, striking his elbow on a concrete floor and bruising his chest on the edge of a large badge which he wore just below his left clavicle. X-rays of elbow and shoulder were made, and a crack in the head of the radius found. This healed, but symptoms of pain and muscular weakness persisted, which were diagnosed as brachial neuritis. His case finally came to the Advisory Council. A review of the films was made by the roentgenologist, who found a fracture of the first

rib about one inch from the sternal end, the larger fragment being displaced downward (Fig 6) Since the symptoms sug-

roentgenologist requested oblique views through the lower dorsal area One of these showed a fractured transverse process



Fig 6 Fracture of first rib near its sternal attachment, with displacement downward of bony portion This film was made at the time of the accident but this fracture was not discovered until the case was reviewed by a consulting roentgenologist several months later More comprehensive examination revealed the cervical rib shown in Figure 7



Fig 7 Small cervical rib, not visible in antero-posterior or lateral views, but shown only in this oblique projection The depression of the fractured first rib shown in Figure 6, to which this cervical rib is undoubtedly attached, produced symptoms of pain along the distribution of the brachial plexus Illustrates the importance of special technical procedures directed by a roentgenologist familiar with the significance of clinical symptoms

gested involvement of the cervical plexus, a survey of the cervical spine was made by x-ray On one of the oblique views a small cervical rib was found (Fig 7), which cannot be seen on any other view of this spine or thorax The final conclusion was that the non-union and depression of the fractured first rib had resulted in pinching the cervical plexus between the two structures, and the relief of this by the proper surgical procedure was advised

In another case of suspected injury to the twelfth dorsal vertebra, three x-ray examinations had failed to disclose positive evidence of injury Finally, the consulting

of the last dorsal vertebra—evidence that a serious injury had certainly been sustained

Most of the cases in this group have had only two views and frequently only a single view, and many of these have to be re-examined In a recent case, the reports stated that a lumbar vertebra was fractured and the film came with a report to prove this diagnosis The medical referee was not certain, while the roentgenologist

was almost certain that the crack in the vertebra was a gas shadow in the overlying colon. The man was ordered re-examined

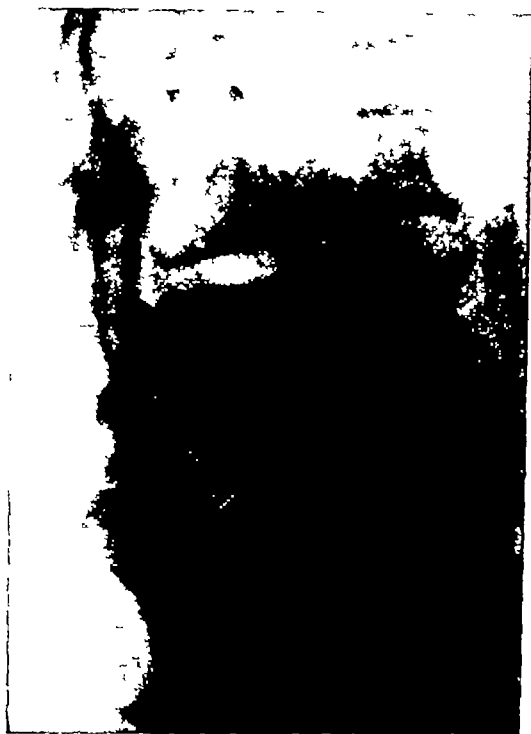


Fig 8 Conditions in the lower dorsal spine found five months after injury the effects of which were supposed to be confined to the pelvis. Failure to secure films of the spine soon after the injury made it impossible to determine whether or not these changes were due to the injury

the body cast was removed, and the film showed that the overlying gas bubble had moved and the fracture was "gone with the wind."

A very graphic illustration of the possible seriousness of faulty technic was that of a man who fell and bruised his hip. No x-ray examination was made as the man could walk. Some weeks later another surgeon examined him on account of persistent pain, making a film of the hip but with the thigh in external rotation—certain sign of an amateur. Diagnosis of an old impacted fracture of the femoral neck was made and the man put in a body cast. When the film came to the medical referee, the roentgenologist said there was no fracture. To prove the point a film was made of a normal pelvis, with one thigh rotated

outward and the other inward. The surgeon treating the man was then requested to remove his cast and have a stereoroentgenogram made with the thigh in internal rotation. This was done and normal femoral neck was shown. Had the first film not been sent to the medical referee for inspection of consulting roentgenologist, this man would have been kept in his body cast for two months, as the surgeon's report stated that was his plan of treatment.

A man with a spine injury which crushed his eighth dorsal vertebra was properly treated and came up for final rating before the Advisory Council because his symptoms seemed greater than the injury would account for. A more comprehensive examination than any which had previously been made showed a fracture of the eleventh dorsal vertebra also.

(c) A third group of cases show bone changes or evidences of injury of questionable relation to the recent accident. It is this type of injury that gives the automobile insurance racketeers their opportunity. These criminals fabricate an automobile accident, claim injury to a part which is known to show bone abnormalities, secure x-ray films from some sympathetic surgeon inexperienced in x-ray appearances, or from some irregular practitioner, improperly though legally permitted to take x-ray films. With these, they scare the insurance company into settlement, and move on to a new field of activity. The racket has invaded the industrial field.

A man had an injury to his pelvis which was x-rayed and found negative. He was treated and discharged by his surgeon. Five months later he turned up and claimed that his back still hurt him, now locating the pain high up. This was examined and old changes found in the lower dorsal vertebrae (Fig 8). He claimed his back had been perfectly normal until the injury five months previously, and while the Advisory Council had grave doubt about these changes having been produced by the injury in question, they were forced to give him the benefit of all doubt and rated him as 15 per cent permanently

disabled. A thorough examination in the outset might have prevented this possible error.



Fig 9 Anomaly in development of second lumbar vertebra. This was found at examination, made the day after the accident. It was re-examined at intervals during the next eight months and no visible change could be detected. Medical Advisory Board decided it was a developmental anomaly, a decision which was made possible because of the prompt examination at time of injury.

In another case a deformed second lumbar vertebra was found in the spine of a young man injured by a fall from a considerable height at Boulder Dam (Fig 9). The appearance of the vertebra never changed during the months following, and the final conclusion at the end of six months was that this deformity was not caused by the fall, but was either a congenitally deformed bone, or an old injury which the patient either could not recall or would not admit.

A recent report came in with a film,

showing multiple fractures of the transverse processes of lumbar vertebrae (Fig 10), which the surgeon thought must have been



Fig 10 Film made immediately after a back injury on a patient who denied previous injury to the back. Surgeon reported the fractures as recent and produced by the injury under treatment. The Medical Referee and the consulting roentgenologist decided they were old and due to some prior injury.

produced by the accident, as the patient denied prior injury. However, the roentgenologist's opinion was positive that these fractures were months and probably years old.

In a wrist injury where the man claimed no previous accident, an old fractured scaphoid was found. During the period of observation, we accidentally ran across some old films of this man's wrist made in 1931. They showed the same condition exactly as it appeared five years later (Fig 11). We have had quite a number of old Kienbock and Preiser lesions in the wrist, where the workmen denied prior injury.

(d) In the fourth group are included those cases showing pathological bone formations which are mistakenly interpreted as related to certain injuries.

In two instances, cases which probably do not belong strictly in this group, the interosseous ridge of the tibia has been

sity The final conclusion was that it must be in the capsular ligament This fragment resembles the os acetabuli which we have



Fig 11 Old divided scaphoid found in a man who denied previous wrist injury While under observation and compensation an old film taken five years previously came to light which showed this identical condition then present

interpreted as a traumatic periosteal proliferation, the interpretation being changed as time brought no change in the shadow

One of the most interesting cases in this group was one where a triangular fragment of bone above the head of femur was interpreted as a fragment broken off the rim of acetabulum (Fig 12) Persistent symptoms seemed to call for its removal, and a competent orthopedic surgeon searched diligently for the fragment, even exploring the hip joint It was not found and subsequent examination showed the same den-



Fig 12 Bony formation at the upper margin of the acetabulum, diagnosed as a fragment detached from the pelvic bone and causing pain Attempt at removal failed, as it could not be found Subsequent examination showed the same shadow and final decision was that it is probably a calcification in the capsular ligament and of no clinical significance

once or twice seen interpreted as fracture of the rim of acetabulum

Two or three times, we have seen calcifications about the elbow joint interpreted as fractures or as associated with neuritis One of these is still a live issue The attending surgeon recommends its removal, and the roentgenologist is unable to agree that it is the cause of ulnar neuritis

An interesting case recently was that of a cowboy who was thrown from his horse and found with a piece of bone protruding from the back of his thigh Films were made and condition diagnosed as a compound fracture of shaft of femur, by the surgeon Cast was applied Abscess of soft tissues developed, and when this was incised several more pieces of bone came

away When the abscess healed, films showed the femur to be intact This was evidently a fracture of an osteoma which was finally eroded away completely by the infection

We must not lose sight of the fact that infections and bone changes may follow injury and may not be shown by the first examination Among the conditions of this type for which the roentgenologist must be on the watch is acute traumatic osteoporosis, the so-called Sudeck's atrophy Since this may not develop for several weeks after injury, it is a serious mistake to consider a first negative report as final for that injury The same caution applies in spine injuries, in which a Kummell deformity may develop when nothing is shown by the first examination This is all in line with our theme that the roentgenologist should be a permanent and constant consultant in all industrial injuries

Having given consideration to the causes and symptoms, we can make a diagnosis of the disease, pseudo-roentgenology, afflicting our specialty and we should be able to outline the treatment As in all medical problems, treatment is the thing we are most interested in

Are the illustrations here presented designed to promulgate the idea that the suffusion throughout our medical organism of small x-ray plants is an unhealthy condition and should be combated? Not necessarily so The leucocytosis resulting from infection is very desirable, but if it changes to a leukemia, that is another matter The general use of x-ray in diagnosis has contributed to medical progress and can contribute still further, but it should be held within the bounds of health That is our problem

The most progressive step we have made in a generation was the organization of The American Board of Radiology, whose function is to determine and specify who shall be entitled to be classed as specialists in roentgenologic interpretation We cannot, of course, expect to have these designations accepted by the public or public

servants until the medical profession itself has accepted them It is not sufficient that the American Medical Association accepts the Board's classification for its medical directory It must go much further than this The Council on Medical Education and Hospitals should lay down as a definite essential for hospitals approved for intern training that the department of diagnostic roentgenology, as well as all radiotherapy, shall be under the supervision and direction of diplomates of the Board of Radiology

Having accomplished this step, we can go to Industrial Commissions and insurance carriers with the demand that competent roentgenologists shall review their cases and personally supervise all difficult examinations Also that only adequate and proper examinations are entitled to be paid for

The courts will be the hardest to deal with, because institutions which have not changed their ideas or procedures in a thousand years find it difficult to keep up with rapidly moving developments Occasionally, we see a flash of intelligence from a jurist in the matter of x-ray examinations, as in the case of one Federal judge who decreed that x-ray films were not needed, so long as the roentgenologist could tell what was shown by them Wise judge, may his tribe increase!

In summary, then, our contention is that only those who are expert shall pretend to be so We have several excellent precedents for this claim The College of Surgeons has been working for years to prevent incompetent surgeons from doing major surgery Even though the American Board of Pathology is just being formed, we would be astounded if a doctor whose only qualification was the possession of a microtome and a microscope should attempt to make tissue diagnoses, and yet exactly that ridiculous situation holds in the field of diagnostic roentgenology Many practitioners carry ophthalmoscopes to observe gross conditions in the eyes, but their opinions would not be accepted in court as against those of ophthalmolo-

gists Illustrations might be multiplied *ad infinitum*

If the hospitals approved by the Council on Education for intern training, and those certified by the American College of Surgeons, were required to have their diagnostic x-ray work directed by approved roentgenologists, if Industrial Commissions and insurance carriers would accept

as conclusive only the findings of such experts, if the courts would hold as of value on these matters the opinions only of those recognized as competent by the bodies qualified to pass on them, we will have gone a long way toward stopping the progress of this disease which is now parasitically flourishing on the fair body of our specialty

EVACUATION OF THE GALL BLADDER IN PEPTIC ULCER PATIENTS¹

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||| N considering extra-biliary lesions that might affect the normal function of the bile passages, one naturally turns first to erosions of the stomach and duodenum, partly because the intake of food is so closely associated with expulsion of bile and partly because it has been suspected, since the time of Claude Bernard (1), that hydrochloric acid plays some rôle in regulating the flow of bile. Furthermore, these lesions vary among themselves, it being now generally recognized that peptic ulcer is characterized by an abundance of free acid whereas carcinoma of the stomach and pernicious anemia are distinguished, respectively, by a decrease and virtual suppression of free acid. Here then, would seem to be an experiment provided by Nature for testing the rôle played by gastric secretion.

To Bronner (2) must go the credit for first pointing out that in peptic ulcer patients the gall bladder empties rapidly. He considered, indeed, that the gall bladder of his ulcer cases exhibited greater motility than that of any normal group of the population. He even went so far as to predict that ulcer could be diagnosed by the rate of emptying of the gall bladder. Since that time, however, more detailed information has appeared concerning the normal rate of emptying in different sex and age groups. We know, now, that individual variation is so great that little can be predicted from a single case. It is only when we obtain the mean curves of

evacuation in a relatively large number of individuals that we can say, for instance, that, on the average, the gall bladders of boys empty much faster than those of girls (3), that after puberty the male gall bladder empties significantly slower than the female (4), and that in old age (5) there is, at least, no diminution in rate of emptying in either sex.

Bronner, however, drew his conclusions from just 12 peptic ulcer cases (four women and eight men) and half of these were complicated by short or long standing gastro-enterostomies. Furthermore, his estimates of gall-bladder volumes were based on purely visual inspection of cholecystograms. It has seemed desirable, therefore, to restudy this problem with the aid of quantitative methods and more adequate controls.

To test the hypothesis outlined above, we have employed the same technic that was used in studying normal individuals. Following visualization of the gall bladder by oral administration of "Iodeikon," cholecystograms were taken at 2, 4, 8, 12, 16, 20, 25, 30, 35, 40, and 45 minutes after a standard meal of four egg yolks, the latter well mixed in an equal volume of milk, seasoned with a pinch of sugar and a few drops of vanilla. The outlines of the gall bladder were then transferred to tracing paper and divided into segments representing circular plinths. From these the changing volumes of the gall bladder were computed according to the methods described in preceding articles (3, 4).

Incidentally, ulcer patients were studied in the order they appeared for diagnosis in the Department of Radiology and before treatment for ulcer had been instituted. Altogether, cholecystograms were made from 33 male patients, of these, 10 series

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² Aided by grants from the Medical Research Fund of the Graduate School. The senior author also wishes to express appreciation to Dr. L. G. Rigler for the facilities generously provided by the Department of Radiology.

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A 11 Gastric Ulcer Patients	Age	Weight lbs	
		Normal	Loss
E Av	56	135	2
E Ga	33	120	
L Go	47	135	9
J Ho	28	180	5
A Le	55	120	10
K Ma	56	135	7
O Mu	36	180	38
H Od	29	165	20
L Ph	51	150	18
D St	51	140	17
G Wi	43	170	20
Mean	48.5 44.1	163.0 148.2	14.6 14.6

B 12 Duod Ulcer Patients			
W Ar	55	175	10
L Ch	40	160	none
J Da	53	165	7
L Gr ¹	46	135	35
E G ¹	68	151	10
M Ha	61	121	37
I He	25	142	17
M Ma ²	33	185	15
C Ra	38	172	5
W Sa	24	165	8
A Sh	29	188	20
W Th	38	148	17
Mean	51.0 42.5	190.7 159	18.7 15.6

¹ On lesser curvature excor
attacks of colic localized in rlg
² Duodenal deformity patient
of pain to scapula and hypoch
14 months after cholecystogram

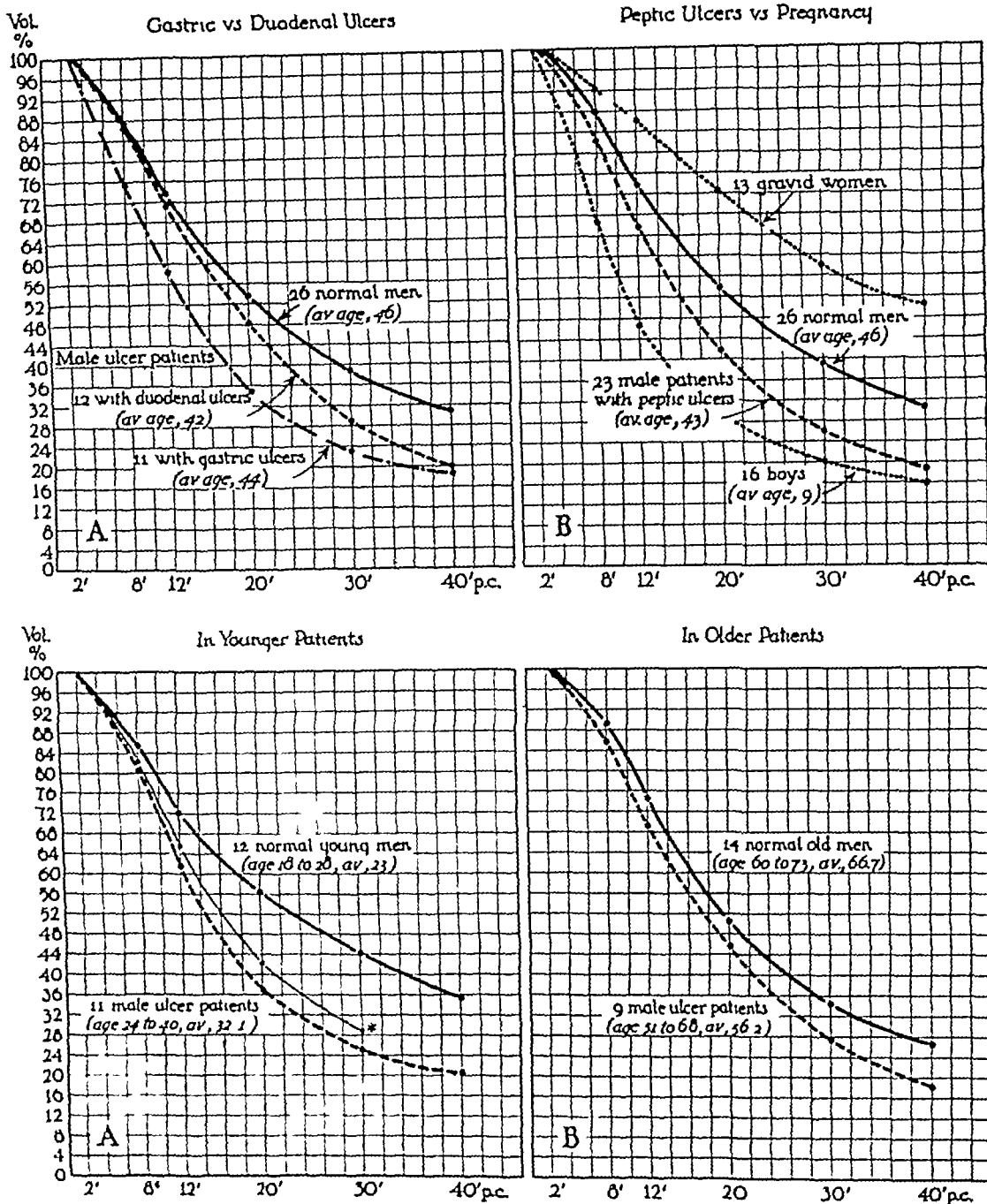


Fig 2 Mean curves of evacuation of gall bladder in peptic ulcer patients reduced to percentage basis (cf Table I) Vol %, mean percentage of bile in gall bladders of a given group at a given time A, gastric and duodenal ulcer curves, B combined peptic ulcer data contrasted with the norm for men (Boyden and Grant-ham, 1936) with the curve for gravid women (Gerdes and Boyden 1936) and with the curve for young boys (Boyden and Fuller 1934) (Upper curves)

Fig 3 Mean curves of evacuation of gall bladder in peptic ulcer patients separated into two groups on the basis of age. A young ulcer patients contrasted with the norm for young men. Asterisk indicates curve for nine normal young men (cf Table III) who were given one egg yolk by duodenal tube (compiled from data of Boyden and Birch 1930) B older patients contrasted with the norm for older men (Lower curves)

not due to chance As in preceding papers the writer is indebted to Dr Edith Boyd of the Department of Anatomy for supervising the statistical analyses

The duodenal ulcer curve, on the other hand, is intermediate in position, and its

differences from the norm are significant only at the forty-minute reading (Table II-D) When, however, both ulcer groups are combined (Fig 2-B) the curve for ulcers is significantly steeper than that for the norm in the 20-, 30-, and 40-minute periods (Table II-B) It is not so steep as the curve for young boys, although the two resemble each other closely in shape By way of contrast, and to indicate the other extreme in rate of evacuation, we have added to Figure 2-B the curve for gravid women (6)

At this point objection may be raised to the fact that the norm is made up of two groups—a combination of 12 young men (age 18 to 28) and 14 older men (age 60 to 73), whereas the 23 men in the ulcer group range all the way from 24 to 68 years of age Their distribution according to decades is as follows

	20-30	30-40	41-49	50-59	60-69
11 Gastric ulcer patients	2	2	2	5	0
12 Duodenal ulcer patients	3	4	1	2	2
Total	5	6	3	7	2
	Group 1			Group 2	

With this grouping as a basis we have made a new set of comparisons (Fig 3-A), placing the mean curve of emptying of Group 1 (made up of 11 ulcer patients below the age level of the climacteric) against the curve of 12 normal young men When these curves are analyzed statistically, the differences are found to be significant in the 20-, 30-, and 40-minute readings (Table II-E) Thus it is clear that in younger men, peptic ulcer markedly accelerates the discharge of bile from the gall bladder

When we turn to the men above the age level of the climacteric (Fig 3-B) the difference between ulcer patients and the norm is not marked enough to be statistically significant (Table II-F) This may mean exactly that which the curves suggest, namely, that erosions of the stomach and duodenum in older groups have less effect on the discharge of bile than in

younger groups Of interest in this connection are the studies of Sagal, Marks, and Kantor (7), who have shown that gastric acidity is highest in the earlier age groups, reaching its peak in the fifth decade, and lowest in later decades Even if free acid is not the cause of accelerated discharge of bile from the gall bladder, decrease in acid in old age may reflect a decrease in the factor which does regulate the rate of emptying and so afford a clue as to why the differences between the ulcer curve and the norm of old age are not greater

On the other hand, the normal curves for old men and women, as pointed out in a previous study (5), are not so satisfactory as those for young men and women, because in the latter group, made up chiefly of medical students, 100 per cent of the gall bladders were visualized, whereas in the former (made up of hospital patients without obvious biliary or gastro-intestinal histories) only 76 per cent of those studied could be visualized So the conservative position was taken that although the gall bladder of old adults was on the borderline of being significantly faster than that of young adults, it was merely because we were dealing with the more favored members of an old age group, namely, those whose gall bladders were capable of being visualized Probably, therefore, our normal curve of emptying for old age is too fast Bearing this in mind, as well as the fact that in Figure 3-B the ulcer patients average ten years younger than those constituting the "normal" old age group, together with the further observation that all the ulcer curves are consistently in the direction of being faster, we have little hesitation in concluding that the effect of peptic ulcer even in older men is to increase the rate of discharge of bile from the gall bladder

DISCUSSION

Granting that the above finding is true, what clinical significance has it? Probably none, for a somewhat more rapid flow of concentrated bile after meals

TABLE II — STATISTICAL ANALYSES

Time Interval (min)	No of Cases	Mean and Standard Error	No of Cases	Mean and Standard Error	Difference and Standard Error	Diff S E	Probability Integral
		A Gastric	vs	Duodenal Ulcer Patients			
8	11	24 61 ± 7 81	12	12 30 ± 5 82	12 31 ± 9 74	1 26	0 208
12	11	41 60 ± 6 63	12	28 17 ± 8 78	13 43 ± 11 00	1 22	0 222
20	11	65 22 ± 4 18	12	51 82 ± 7 85	13 40 ± 8 89	1 51	0 131
30	11	77 10 ± 3 01	12	71 07 ± 4 87	6 03 ± 5 73	1 05	0 293
40	11	81 69 ± 2 94	12	79 95 ± 4 09	1 74 ± 5 04	0 35	0 727
		B Ulcer Patients	vs	Normal Males			
8	23	18 18 ± 4 88	26	12 12 ± 2 16	6 06 ± 5 34	1 13	0 258
12	23	34 59 ± 5 63	26	26 59 ± 3 50	8 00 ± 6 63	1 21	0 226
20	23	58 23 ± 4 68	26	46 62 ± 4 56	11 61 ± 6 53	1 78	0 075
30	23	73 96 ± 2 93	26	60 83 ± 3 51	13 13 ± 4 57	2 87	0 0037
40	23	80 78 ± 2 51	26	69 30 ± 3 02	11 48 ± 3 93	2 92	0 0037
		C Gastric Ulcer Patients	vs	Normal Males			
8	11	24 61 ± 7 81	26	12 12 ± 2 16	12 49 ± 8 10	1 54	0 124
12	11	41 60 ± 6 63	26	26 59 ± 3 50	15 01 ± 7 50	2 00	0 046
20	11	65 22 ± 4 18	26	46 62 ± 4 56	18 60 ± 6 19	3 00	0 0027
30	11	77 10 ± 3 01	26	60 83 ± 3 51	16 27 ± 4 62	3 52	0 00050
40	11	81 69 ± 2 94	26	69 30 ± 3 02	12 39 ± 4 21	2 94	0 0037
		D Duod Ulcer Patients	vs	Normal Males			
8	12	12 30 ± 5 82	26	12 12 ± 2 16	0 08 ± 6 21	0 01	0 992
12	12	28 17 ± 8 78	26	26 59 ± 3 50	1 58 ± 9 45	0 17	0 865
20	12	51 82 ± 7 85	26	46 62 ± 4 56	5 20 ± 9 08	0 57	0 569
30	12	71 07 ± 4 87	26	60 83 ± 3 51	10 24 ± 6 00	1 71	0 087
40	12	79 95 ± 4 09	26	69 30 ± 3 02	10 65 ± 5 08	2 10	0 036
		E Young Ulcer Patients	vs	Normal Young Males			
8	11	19 80 ± 6 03	12	14 3 ± 3 37	5 50 ± 6 91	0 80	0 424
12	11	38 36 ± 8 64	12	28 0 ± 5 77	10 36 ± 10 39	1 00	0 317
20	11	63 33 ± 6 65	12	43 5 ± 7 59	19 83 ± 10 09	1 97	0 049
30	11	74 81 ± 4 79	12	55 7 ± 5 43	19 11 ± 7 24	2 64	0 0093
40	11	79 25 ± 4 23	12	64 6 ± 4 75	14 65 ± 6 36	2 30	0 021
		F Old Ulcer Patients	vs	Normal Old Males			
8	9	14 18 ± 9 89	14	10 29 ± 2 78	3 89 ± 10 27	0 38	0 704
12	9	28 81 ± 9 40	14	25 42 ± 4 39	3 39 ± 10 37	0 33	0 741
20	9	51 64 ± 8 50	14	49 29 ± 5 60	2 35 ± 10 18	0 23	0 818
30	9	72 34 ± 4 53	14	65 25 ± 4 37	7 09 ± 6 29	1 13	0 258
40	9	81 77 ± 3 67	14	73 27 ± 3 78	8 50 ± 5 27	1 61	0 108
		G Normal Males (5 yolks by mouth)	vs	Normal Males (1 yolk by tube)			
8	12	14 26 ± 3 38	9	17 87 ± 6 49	-3 61 ± 7 32	49	0 624
12	12	27 96 ± 5 79	9	34 28 ± 7 42	-6 32 ± 9 41	67	0 503
20	12	43 51 ± 7 59	9	57 62 ± 5 04	-14 11 ± 9 10	1 55	0 121
30	12	55 67 ± 5 46	9	70 99 ± 3 90	15 32 ± 6 71	2 28	0 023
40	12	64 55 ± 4 81					

more he suspects that their existence cannot be ruled out until the mean value has been obtained in a larger number of cases,

has yet determined the minimum amount of egg-yolk in the duodenum necessary to produce a maximum phase of contrac-

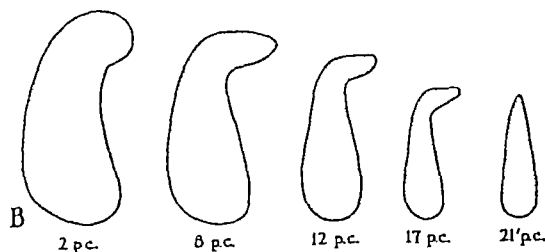
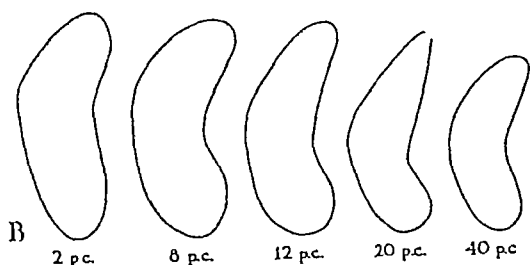


Fig 6 Case *Ar* (Table I-B and Fig 1-B)
A, roentgenogram of stomach and duodenum (*N* = niche of duodenal ulcer), B, tracings of cholecystograms showing slow emptying of gall bladder

Fig 7 Case *Ma* (Table I-B and Fig 1-B)
A, roentgenogram of stomach and duodenal cap (*N* = niche of duodenal ulcer), B, tracings of cholecystograms, showing fast emptying of gall bladder

probably because the biliary tract is regulated by a number of factors, any one of which may, upon occasion, be masked by another. However, the evidence is quite convincing that the human gall bladder, as contrasted with that of the cat (10), for instance, is not subject to reflexes originating in the stomach, for painful faradic stimulation applied through a Rehfuß tube causes neither contraction of a relaxed gall bladder nor inhibition of one that is evacuating after a fatty meal (11). Whatever effect is produced by increased motility of the stomach must, therefore, act in another way—perhaps through the discharge of larger quantities of food into the duodenum in the first half-hour after a meal.

So far as the writers are aware, no one

tion of the gall bladder. It must be quite small, for we have repeatedly induced it by injecting just one egg-yolk (30 cc by volume, when mixed with water, 12). Incidentally, the mean curve of evacuation in nine such cases is significantly faster than in a comparable student group to whom four or five egg-yolks were given by mouth (Fig 3-A, see *, and Table II-G). Therefore, it is quite probable that the tendency of the stomach in peptic ulcer patients to discharge its contents with an initial rush—as Dr Rigler informs the writers is usually the case—is an important factor in accelerating the discharge of bile.

In this sense, but not in the sense of Bronner (2), who considered that the vagus acted directly on the gall bladder of

would seem to have no physiological significance, especially since such a rate of flow would be within the limits of nor-

gal bladders of which empty at greatly differing rates (4-B and 5-B). So with the duodenal niches (Figs 6 and 7) In

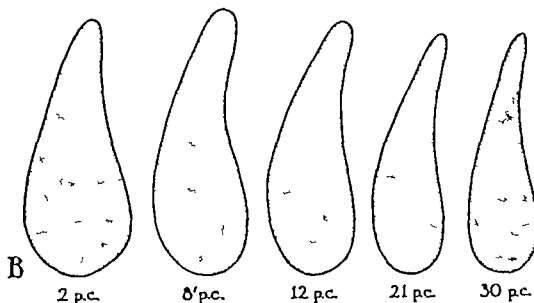


Fig 4 Case *Ho* (Table I-A and Fig 1-A) A roentgenogram of stomach (C = crater of large gastric ulcer), B tracings of selected cholecystograms showing slow evacuation of gall bladder

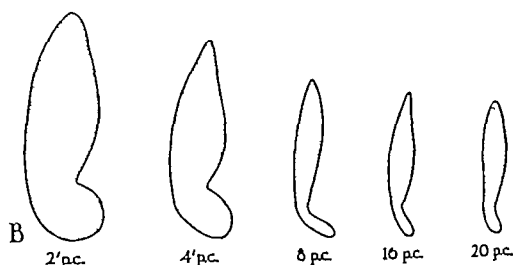


Fig 5 Case *Ph* (Table I-A and Fig 1-d) A, roentgenogram of stomach (C = large perforating ulcer), B tracings of cholecystograms showing fast emptying of gall bladder

mal variation. Its value then is chiefly negative, it strongly suggests that one does not need to fear that peptic ulcer will lay the foundation for biliary disturbances. This, of course, is in marked contrast to the prognosis which prevails in pregnancy.

However, the fact that the influence of ulcerations on the biliary tract is benign does not render it any less important, because it may eventually throw light on the mechanism of biliary disease. What factors, then, are responsible for this acceleration of flow? Does the size of the ulcer, for instance, make any difference? Apparently there is no obligatory relation between the two, for if we compare Figures 4 and 5 we see two craters of the same size (4-A and 5-A), the associated

this connection, however, it may be noted that in a larger series Vanzant, *et al*, have reported that the acidity varies with the size of the ulcer (8).

Secondly, does the increased motility of the stomach play any rôle, either through reflex stimulation of the gall bladder and sphincter of Oddi, or through the initial delivery into the duodenum of larger volumes of hormone-provoking food? Superficial studies would suggest a negative answer, for it is not difficult to find individuals in whom a rapidly emptying gall bladder is associated with an eight-hour stomach or with a sluggish intestinal tract that requires 120 hours for the passage of a barium meal (9). Nevertheless, the more one deals with such factors the

have shown that the mean for gastric secretion in duodenal ulcer patients is only on the borderline of being significantly higher than the normal mean. The mean for achlorhydria and especially the mean for pernicious anemia, however, are significantly lower than the normal. In view of these various considerations it would be folly at this time to deny the possibility that free acid is an acceleratory factor in the evacuation of bile in peptic ulcer patients. On the other hand, it would seem that the effects of peptic ulcer could be explained without resort to the theory of stimulation of the duodenum by spurts of acid chyme. It is hoped that our impending study of pernicious anemia patients may afford another means of separating the acid from the food factor, for in such patients we may expect a steady initial flow of food from the stomach that would be unmixed with free acid. In this connection, it may be noted that our first returns on patients with carcinoma of the stomach (21) indicate that in this disease the gall bladder empties at a normal rate.

SUMMARY

(1) Visualization of the gall bladder (oral method) occurred in 30 out of 33 peptic ulcer patients.

(2) From this number, 23 good series of cholecystograms were obtained after a standard meal of four egg-yolks and milk.

(3) Computation of the changing volumes of the gall bladder has indicated that at least in men under forty, and probably in older men as well, peptic ulcer markedly increases the rate of evacuation of the gall bladder.

(4) In discussing the various factors that might be responsible for this accelerated discharge of bile, it was shown that when a single egg-yolk is placed directly into the duodenum the gall bladder empties significantly faster than when four or five egg-yolks are given by mouth.

(5) It is suggested, therefore, that the greater tonus of the stomach in peptic ulcer cases may be responsible for a greater

initial rush of food into the duodenum, which, in turn, causes faster evacuation of the gall bladder. Possibly, also, this vagotony may relax the sphincter of Oddi.

(6) The theory that the large amounts of free acid in the stomach of peptic ulcer patients may also provoke the duodenum to greater production of cholecystokinin is withheld pending a survey of the rate of emptying of the gall bladder in achlorhydric patients.

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TABLE III —EMPTYING OF GALL BLADDER IN NINE NORMAL YOUNG MEN AFTER INJECTION OF ONE EGG-YOLK INTO DUODENUM

Volume of Gall Bladder at											
Name	Age	Wt	2 min	8 min		12 min		20 min		30 min	
				Percent- age Loss		Percent age Loss		Percent age Loss		Percent- age Loss	
			c cm	c cm		c cm		c cm		c cm	
W F (Fig 3*)	20	115	25 8	18 2	29 50	14 8	42 64	10 3	60 00	10 30	60 00
M K (Fig 2*)	21	128	28 0	27 6	1 43	22 2	30 57	10 35	63 00	7 40	73 57
G A K (Fig 1†)	30	130	32 61 (4 pc)	17 56	46 14	11 21	65 62	11 07	66 06	7 52	78 28
E D P (Fig 3*)	23	140	19 63	19 26	1 88	18 89	3 77	15 00	23 58	9 45	51 80
A R (Fig 1†)	16	165	68 76 (4 pc)	67 86	1 31	60 80	11 58	35 55	48 30	25 11	63 48
M M S (Fig 3*)	22	130	20 96	19 93	5 10	15 94	24 10	9 30	55 71	2 51	88 05
T J W (Fig 3*)	21	154	22 58	14 31	33 63	10 62	52 97	9 00	60 14	8 16	63 87
A D W (1) (Fig 1*)	21	149	46 08	26 82	41 80	18 20	60 51	9 90	78 52	(19 92)	80 08
A D W (2) (Fig 1*)	21	149	61 99 (4 pc)	(62 58)	00 00	51 60	16 77	22 80	63 23	12 60	79 68
Mean	195 22	1260 140	326 41 36 27	160 79 17 87	308 53 34 28	518 54 57 62	638 87 70 98				

* For individual curves of contraction, see *Boyden and Birch*, 1930

† For curve, see *Boyden and Saunders*, 1928

ulcer patients, increased flow of bile in the presence of peptic ulcer may be attributed to the fact that the patient is vagotonic. Of special interest in this connection is Babkin's observation that the gastric glands on the lesser curvature are more actively under the control of the vagus than those in the region of the greater curvature (13). Whether the human sphincter of Oddi, as contrasted with the occluding apparatus in mammals (14), is also subject to vagotomy has yet to be proven but cannot be disregarded.

This brings us to our third query. To what extent is the discharge of bile influenced by increments of free acid from the stomach? As indicated in the reviews of the subject by Babkin (15) and Ivy (16), there is abundant evidence that in animals, dilute HCl introduced into the duodenum causes contraction of the gall bladder and a drop in pressure at the outlet of the common duct. But in man, our experience has been that in four out of eight attempts, duodenal injection of 20 to 40 c c of dilute acid ranging from 10° to 75° produced merely a small reduction of the gall-bladder shadows, lasting from 8 to 14 minutes only and never resulting in aspiration of B bile (12). In our present

state of knowledge regarding the formation of gall-bladder hormones, what effect the acid would have when mixed with egg-yolk can only be conjectured. Furthermore, if the free acid were the critical factor in the acceleration, we would expect the curve of evacuation in duodenal ulcer patients to be faster than those with gastric ulcer—the reverse of the situation in Figure 2-A—for several authors (8, 17, 18) have recently shown that the highest acid values are associated with duodenal ulcer.⁴

On the other hand, the distinguishing feature of gastric secretion in man, as contrasted with the dog—in which animal it is produced only at maximum concentration (19)—is its great variability, both in concentration and in quantity. Thus Berglund, Johnson, and Chang (20) who have taken the position that the important measure of gastric secretion is not the free acid but the total output of chlorides,

⁴ In our series the record of histamine tests indicates that the amount of free acid is approximately the same for gastric and duodenal ulcer groups (Table I). But these routine hospital reports cover only 16 patients and are otherwise incomplete. They are included to show that all but one of the patients tested had free acid and that the titer was within the range of what is considered normal.

THE RÔLE OF THE VEGETATIVE NERVOUS SYSTEM IN THE PRODUCTION OF MOTOR PHENOMENA OBSERVED IN THE UPPER DIGESTIVE TRACT¹

By ALFRED C SIEFERT, M D, *Oakland, California*

THIS paper aims to discuss the motor phenomena which may be observed in the upper digestive tract, particularly in the stomach, and which have been observed for years by every physician interested in clinical gastro-enterological roentgenology. The writer will make an attempt to correlate these motor phenomena with facts and theories concerning the vegetative nervous system.

During the present period of morphologic roentgen diagnosis the so-called "functional findings" are looked at somewhat askance. Greater attention to them, however, is bound, in the writer's opinion, to extend the scope of our ideas, especially along the lines of the causation, and to deepen our conceptions of organic gastrointestinal disease, and furthermore, to make us more alert to the importance of psychoneurotic, endocrine, and allergic disturbances with reference to the digestive tract. The relationship between peptic ulcer, for instance, and psycho-neurotic influences is not a new conception. It is, in fact, observations and experiences of this phase that have aroused the writer's particular interest in the entire subject.

The observations and experiences laid down in this essay cover a period of 18 years of hospital and private roentgenologic practice. One may remark that the last years of the economic depression, especially, which have brought many individuals under heavy nervous strain, have been particularly fruitful in yielding material for the discussion in hand. Patients with gastro-intestinal symptoms directly traceable to nervous tension are found particularly among business and professional men and quite frequently among members of the medical profession.

The method of examination primarily used has been, of course, fluoroscopy, and

it is frequently impossible to hold fast on roentgenograms what has been observed on the screen. Such refinements as aimed roentgenography, roentgen-cinematography, and roentgen-kymography have not been at the writer's disposal.

The motor manifestations in the upper digestive tract may be classified in three groups from which all other motor phenomena may be derived. They are (1) tonus, (2) peristalsis, (3) sphincteric action.

Tonus—The chief manifestation of tonus is the so-called "peristolic function, exercised by the smooth musculature of a hollow viscus. It is thus that the organ contracts closely about its contents. Tonus may be divided into three clinical states: the normal, to which we refer as the *orthotonic state*, increased contractability of a hollow viscus is called *hypertonus*, and a decrease below the normal, which allows the contents to sink by gravity to the lowest portion of the stomach, for instance, is called *hypotonus*, and, in extreme cases, *atonus*. To the tone of the longitudinal musculature of the stomach the latter owes its shape. Localized increase of tonus is termed "spasm" the "spastic incisura" and "hour-glass contraction," the latter so frequently an accompaniment of peptic ulcer, are examples. The increase in height and thickness and complexity of the gastric rugæ are expressions of increased tonus of the muscularis mucosæ of the stomach. It is rarely justifiable to interpret this condition as significant of gastritis, but a hypotonicity of the muscularis mucosæ, evidently associated with a lack of turgor in the mucosa, is quite commonly a sign of hypochlorhydria.

Peristalsis is the rhythmic contraction of the circular musculature of the stomach, beginning at the cardia on the lesser curvature, in the region where the myogenic theory of Alvarez places a pacemaker, and proceeds with increasing vigor

¹ Presented before the Radiological Society of North America at the Twenty-second Annual Meeting, at Cincinnati, Nov. 30-Dec. 4, 1936.

(16) IYI A C The Physiology of the Gall Bladder *Physiol Rev* 1934, 14, 1

(17) WINKELSTEIN, ASHER One Hundred and Sixty-Nine Studies in Gastric Secretion During the Night *Am Jour Digest Dis and Nutrition* 1935, 1, 778

(18) FATZER HEDWIG Ueber fraktionierte Magen- und Galle-Entleerung nach Histamin-Verabreichung *Schweiz med Wchnschr*, 1935, 65, 113

(19) KATSCHE Quoted by Berglund, *et al*, 1935

(20) BERGLUND, HILDUNG, JOHNSON, RICHARD, and CHANG H CHEN The Relationship between Hydrochloric Acid and Total Chlorides in Gastric Juice and on the Possibility of Standards for Gastric Secretion *Acta Med Scand*, 1935 86, 269

(21) BOYDEN, EDWARD A and RITCHIE W P The Evacuation of the Gall Bladder in Patients with Carcinoma of the Stomach (Unpublished data)

DISCUSSION

DR LEO G RIGLER (Minneapolis, Minn) I just told Dr Boyden that I was very glad Dr Garland invited him here because now you will think I am a scientist also!

Of course, I am not

I think this is a very beautiful presentation Every time I hear it I enjoy it all the more, and the only thing I want to emphasize is Dr Boyden's method of approach in the study of this problem

Some of you no doubt have read some of the papers, particularly one recently presented by Kirklin and Good on the question of the demonstration of a diseased gall bladder or the apparent demonstration of a diseased gall bladder as a result of some extrinsic factor, and that type of study is extremely important in trying to rule out the errors which might occur in ordinary cholecystography

Dr Boyden's approach is an entirely

different one in which, by using the normally visualized gall bladder, he tries to determine the effect of extra-biliary disease upon its emptying In many ways this is a more effective method if you can do it, because approaching it from the opposite angle, the non-visualization of the gall bladder involves many other factors of error which are not present in this type of study

I think that all of us would do well to think of these charts and to observe carefully this manner of study, because if you have seen it to any extent you realize how very accurate this procedure is, how well it works out in the study of all the physiological processes which involve the gall bladder

DR EDWARD A BOYDEN (closing) I really have not anything more to say other than to answer Dr Kirklin's question and to thank you for your very courteous attention and kind remarks

The problem that Dr Kirklin has mentioned is, perhaps, the most difficult of all, because in gall-bladder disease it is so hard to secure good cholecystograms and, therefore, to obtain mean curves of emptying from a large enough sample of the population The problem could best be attacked by someone like Dr Kirklin who has large numbers of patients coming through a clinic and who could sidetrack for special study all pathologic cases that were visualized

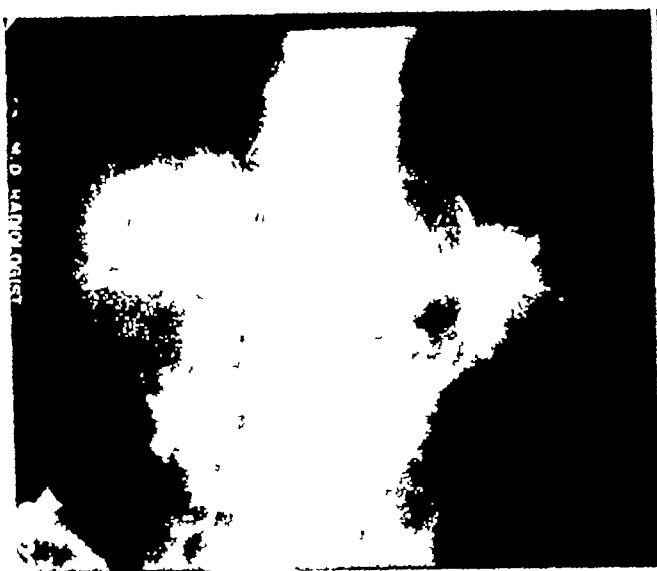


Fig 2



Fig 3

Fig 2 D1730 *Diagnosis* Ulcer of the duodenal bulb, penetrating type Crater retains barium at six hours The fully distended stomach showed no notable vegetative nervous system abnormalities, excepting a persistently spastic duodenal bulb The mucosa of the stomach shows a delicate serpentine pattern, the general course of the rugæ, however, is parallel and they sweep in a gentle curve toward the pylorus The "spidery" deformity of the duodenal bulb is considered spastic to a considerable degree There was no six-hour residue in the stomach but a retention of barium in the ulcer crater *Comment* Illustrates predominantly augmentative effects in the presence of organic pathology in the duodenal bulb

Fig 3 D1578 Recurrent thyrotoxicosis following thyroidectomy Present metabolic rate, plus 25 per cent Essential hypertension Blood pressure variable 130/80-160/90 The clinical symptoms of the thyrotoxicosis are all quite marked Gastro-enterostomy for duodenal ulcer in 1924 ulcer had perforated Examination of digestive tract shows findings which one would class as "vagotonic," even in so definite a "sympathetotonic" disease as thyrotoxicosis, and, in the writer's experience, this is quite typical The patient exceeds the description quoted from Harvey Cushing The mucous membrane examination is able to demonstrate a definite jejunal ulcer of the penetrating type just beyond the stoma The duodenal bulb shows cicatricial stenosis The gastro-enterostomy is efficient in draining the stomach *Comments* Illustrates in a constitutionally psychoneurotic the recurrent development of peptic ulcer, complicated by thyroid and adrenal dysfunction The phenomena in the digestive tract are predominantly augmentative.

tergo may be insufficient to empty the stomach within the six-hour period

The motor phenomena observed in the esophagus and in the small bowel are the same in principle as those described for the stomach

Before taking up the vegetative innervation of the esophagus, stomach, and small bowel, it will be desirable to say a few words concerning the vegetative nervous system in general To discuss it in detail would consume too much time, but a short discussion of the more recent ideas concerning it will undoubtedly be of interest

The older still widely prevailing, conception of the vegetative nervous system based principally upon the work and ideas of Gaskell Eppinger, and Hess, and more recently of Langley and his school, is a

dualistic one Two phases, the "parasympathetic" and "sympathetic" divisions are conceived as acting in more or less strict antagonism to one another This conception is founded not so much upon anatomical grounds or even on strictly physiologic ones, but rather upon the response to certain drugs which act on particular phases of the vegetative nervous system

The vegetative nervous system, furthermore, is conceived as an aggregation of efferent neurons located within as well as without the central nervous system It is, as a matter of fact, by no means as autonomic as is frequently implied or expressed, but is functionally and anatomically associated with both visceral afferent components as well as somatic afferent components The afferent components are,



Fig 1 A normal stomach, perhaps slightly hypotonic

and depth to the pylorus. Normally, three waves travel at a time, to this, one may refer as *normal rhythm*. The time required for a given wave to reach the pylorus is greatly variable and may be called the *speed of peristalsis*; it averages about 24 seconds. Increased rhythm and speed signify motor excitement and frequently accompany organic disease, either in the stomach itself or elsewhere in the abdomen. The *obstruction* type of peristalsis is a familiar phenomenon and illustrates the fact that hypotonicity may be accompanied, at least occasionally, by increased rhythm and speed of peristaltic action.

During the act of vomiting one may now and then see antiperistalsis. One does not, however, expect to see the normal finely co-ordinated "pylorusward" peristaltic waves passing in a similar way in reverse direction.

Irregularity of peristalsis as to rhythm and speed as well as depth is occasionally seen, especially in the presence of peptic ulcer of the stomach. M. Frankel has demonstrated by roentgen-cinematographic methods a section of abolished peristalsis far beyond the confines of a peptic ulcer and its inflammatory infiltrative surround-

ings. He interprets this as a localized spasm of the musculature.

Chemical physical factors, actions upon the mucosa also influence the rhythm and speed of peristaltic action. The presence in the stomach of hydrochloric acid or sodium chloride acts as stimulants, while alkalis and oil have an inhibitory effect. If the opaque drink be given hot, one notes an acceleration and increased vigor of peristaltic action. When it is given cold, inhibition is noted. It is also true that psychic factors have a profound effect upon peristaltic action, as well as the tonus. Thus the writer has frequently observed when a patient is fearful and apprehensive of the unusual surroundings in the fluoroscopic room. Everyone has also seen peristaltic activity of the stomach begin and become increasingly vigorous on the suggestion of palatable food. Finally, blood-borne influences are not to be forgotten.

Sphincteric Action—The opening and closing of the pylorus to an oncoming peristaltic wave is regulated probably by the so-called "duodenal-pyloric" reflex, which causes the pylorus to contract in the presence of acid chyme in the duodenum and produces relaxation when the gastric contents are neutral or alkaline. Of course, there is here, also, evidence of remote control, outside of factors which would increase the hydrochloric action of the stomach. The writer has frequently seen on examinations repeated year after year on the same patient a purely psycho-neurotic spasm of the pylorus with large six-hour retention of barium in the stomach. Similar spasm may be induced by the presence of lesions elsewhere in the gastro-intestinal tract—appendicitis, for instance—or even outside of the digestive system—kidney stone, gallstone, etc. During the act of vomiting the pyloric sphincter is spastically closed, the cardia relaxed.

Relaxations of the pylorus are seen in the presence of achlorhydria and conditions remote from the pylorus, producing achlorhydria. They are also seen in individuals presenting the hypasthenic habitus with ptotic stomach, though the peristaltic *vis a*

gastro-intestinal tract receive augmentative as well as inhibitory impulses from either one or the other of the two vegetative divisions

Dale and Feldberg have recently reported the formation of acetylcholine at sympathetic end-organs by stimulation of the abdominal sympathetic chain. This upsets the teaching that "sympathin," said to be identical with "adrenalin," is liberated at the end-organs of the sympathetic post-ganglionic neurons only, whereas acetylcholine has hitherto been reserved for the end-organs of the parasympathetic system.

Kuntz concludes that mutual synergism rather than antagonism of the two components of the vegetative nervous system is the mode of their functional activity. He regards the parasympathetic as bearing inhibitory as well as augmentative phases. To be sure, it is now accepted that parasympathetic and sympathetic nerves freely intercommunicate, and this may be one of the reasons for the discrepancies and paradoxes in the results of pharmacological and section experiments, also a reason for failure or lack of permanency of therapeutic results, *e.g.*, in essential hypertension on surgical intervention with the sympathetic (splanchnicotomy). A further important consideration is whether, in experiments, one is dealing with a pre-ganglionic tract or a post-ganglionic tract.

Most interesting is the theory of Kiss which has been elaborated for the stomach by Rathkoczy in a recent communication (10). Kiss's deductions are based upon morphologic characteristics which make it possible to distinguish between the vegetative nerve cell and the afferent-sensory nerve cell. He arrives thus at the following revolutionary conclusion:

For the assumption of the so called cranial parasympathetic system we have no morphological basis. The cranial parasympathetic is nothing else but a part of the cranial sympathetic.

Concerning the most important representative of the parasympathetic system, the *vagus nerve*, Kiss states in substance that



Fig 6 D1922 *Diagnosis* Prepyloric ulcer lesser curvature just beyond the incisura angularis. The stomach is only moderately hypertonic. Persistent tenderness is noted on palpation over the ulcer region of the lesser curvature. The peristalsis lacks vigor, three-wave rhythm, the speed is retarded. The pylorus is, if anything, slightly relaxed. The duodenal bulb is irritable, and though well shaped, does not retain barium very well. At six hours the small residue remains in the stomach. A study of the mucosal pattern shows a definite niche on the lesser curvature. The mucosal pattern is irregular and the ruga are increased in prominence. On the day of this examination the pylorus was quite spastic. It was possible to check this case in three months after the above examination and a more definitely formed crater is now demonstrable, with more definitely increased tonus, increased rhythm and speed of peristalsis and spasm of the pylorus. *Comments* Illustrates predominantly inhibitory effects in the presence of prepyloric peptic ulcer which become as the ulcer develops predominantly augmentative. It may be possible to draw prognostic conclusions.

"Distally to the base of the brain the vagus is no longer an unmixed (sensory nerve), but contains sensory, motor, and sympathetic fibers. The sympathetic (visceral) elements do not belong to the original vagus, but reach it by way of anastomoses with the cervical sympathetic ganglia and the spinal accessory nerve from which later it receives also its motor components.

In man, in whom both vagi enter the abdominal cavity, the left vagus innervates the stomach with its terminal branches. The right vagus anastomoses with the celiac plexus by one or two rami, which, however, contain less than 25 per cent of the fibers originally present



Fig 4



Fig 5

Fig 4 D1330 *Diagnosis* Acute duodenal ulcer Six hour retention of barium meal in the stomach evidently due to spastic pylorus Acute exacerbation of chronic appendicitis Increased tonus of stomach, deep regular peristalsis not increased in rate or speed in fact perhaps both are decreased Pyloric antrum is perfect Duodenal bulb shows an ulcer crater The halo' or cushion' effect is due to inflammatory swelling of the surrounding mucosa which marks the ulcer as an acute one There is considerable six hour retention in the stomach pressure tenderness over the duodenal bulb as well as the appendix also muscular guard, all of which may be regarded as an overflow of afferent sensory impulses into the cerebro-spinal and psychic sphere *Comments* Illustrates how peptic ulcer may be secondary to irritation of vegetative system by organic disease (infection) of the appendix Augmentative and inhibitory phenomena are present simultaneously

Fig 5 D1465 *Diagnosis* Duodenal ulcer chronic with organic deformity of the bulb Attention is called particularly to the spastic incisura on the greater curvature of the stomach The tonus of the stomach is markedly increased, and on the greater curvature the aforementioned spastic incisura is noted At times increased rhythm of peristalsis is observed and increased speed The pyloric antrum is persistently spastic but may be filled out by palpatory maneuvers An ulcer crater in the duodenal bulb can be demonstrated with "pouching" at the base of the bulb A large six-hour residue remains in the stomach Arteriosclerosis of one of the branches of the celiac axis is suspected *Comment* Illustrates very marked predominating augmentative effects in the presence of organic disease in the duodenum of a very chronic character

strictly speaking, not usually regarded as part of the vegetative nervous system

From the clinical point of view, however, such a separation seems to the writer purely artificial and useful only for didactic purposes In fact, there are anatomical and neurocytological data that have recently been brought forward by F Kiss which would seem to show that there is a very intimate association between afferent-sensory neurons and efferent-visceral and effector-neurons

The function of the vegetative nervous system within the view of this paper is the regulation and co-ordination of motor activities in the digestive tract The regulation of secretory as well as circulatory

activities in the digestive tract are also of great importance, though they may be studied only indirectly by the radiologist.

Functionally, in general, *augmentative* effects are ascribed to the *parasympathetic* (vagus) system, while inhibitory effects are largely considered to be the result of activity of the *sympathetic* system It is, however, becoming increasingly difficult to explain observed facts on the basis of a strictly dualistic antagonistic theory, and many authors resort to assumptions and explanations which strike one as rather confusing L R Mueller admits that the antagonism is not so constant and reliable a phenomenon as to permit the formulation of natural law since many parts of the



Fig 8-A



Fig 8-B

Figs 8-A and 8-B D1792 There is no evidence of gross organic pathology in the digestive tract, even the duodenal bulb, which one might hold under suspicion, I think, one can prove innocent. Attention is, however, called to such vegetative nervous system phenomena as increased tonus of the stomach, increased tonus of the muscularis mucosa of the stomach, increased vigor of peristalsis, and marked spasm of the pylorus. There are similar spastic phenomena in the small gut and there is a combination of hyper- and hypomotility. Through the stomach and small bowel the meal is delayed considerably beyond the normal period, whereas through the large gut the passage of the meal is accelerated. The colon shows marked spasticity. *Comment* Illustrates in the absence of organic pathology mixed augmentative and inhibitory effects.

sympathetic centers is regarded as impossible by most authors. Vegetative centers are assumed in the cortex, but there are yet no definite anatomical proofs. From a clinical point of view, it would seem that such centers exist. Next to the hypothalamus the medulla oblongata is regarded as the site of most important vegetative centers, and lastly the spinal cord itself. Communication with the outlying paravertebral ganglia is established by the white communicating ram and, as such the splanchnic nerves may be considered in relation to the celiac ganglion, i.e., preganglionic fibers in the splanchnics. Postganglionic are most of the fibers proceeding from the neurons of the celiac ganglion to the organs innervated. The peripheral vagus carries largely postganglionic fibers.

As has already been stated, the conception of the vegetative nervous system as a system of efferent neurons, purely, is

probably too narrow a conception, at any rate, to serve the clinician. That visceral sensations are more primitive and of an entirely different character from the somatic may be conceded without argument. That they exist as visceral sensations is equally certain, and they do not constitute only an overflow into the somatic-cerebrospinal sensory sphere. They may, in fact, rise in visceral afferent pathways by way of the thalamus and, especially the paleothalamus, to the cerebral cortex, and find expression in consciousness. It has been mentioned above that, according to Kiss, the sympathetic ganglia consist of both sensory and sympathetic cells. This investigator, incidentally, suggests that these ganglia may act as "transformers" in that an incoming sensory stimulus is there communicated to an efferent neuron and translated into visceral activity. Of course, reflex arcs of this nature may be instituted at higher or lower levels.



Fig 7-A



Fig 7-B

Figs 7-A and 7-B D1915 A gross organic lesion of the digestive tract can be ruled out. There are many motor phenomena which mark this case as a disturbance of the vegetative nervous system, and I think on a psychoneurotic basis. To re-enumerate these symptoms, the following are of importance. The striking acceleration and irritability of the heart, the relaxation of the esophagus and aerophagia, marked hypertonicity of the stomach with increased rhythm and rate of peristalsis, moderate six hour retention, and spastic colon. According to the referring physician, the patient is highly neurotic, in fact, psychoneurotic. The patient himself states that he is at the present time working under a strain and is very nervous. His chief complaints are nausea, indefinite abdominal distress, and frequent belching. Gall bladder functions normally, and shows no gross anatomical pathology. *Comment:* Illustrates predominantly augmentative effects on stomach and bowel inhibitory on esophagus. This patient may or may not develop peptic ulcer. The sensory symptoms are considered to be produced by abnormal motor phenomena.

in the vagus, but consist mostly of sympathetic fibers.

"The effective motor and secretory innervation of the digestive tract is carried out exclusively by the sympathetic system."

According to Kiss's comparative anatomical researches and the embryologic studies of Campenhout, the celiac ganglion and the abdominal prevertebral ganglia belong to the system of the sympathetic.

The vagus, compared to the spinal nerves, shows that in its posterior sensory ganglia, the ganglion jugulare and nodosum, there are present dark-staining multipolar cells of sympathetic character in addition to the less heavily stained and larger sensory neurons. The accessory nerve represents in this analogy the motor root of a spinal nerve. To reiterate, distally to the base of the brain the vagus

represents a "sensory-motor-sympathetic nerve."

Finally, concluding, Kiss says

"In my anatomical and microscopic researches I found no morphological evidence for the assumption of a so called 'parasympathetic system' in connection with the vagus. It appears that the parasympathetic represents only a phenomenon which may be looked upon as a negative phase of the sympathetic."

Kiss thus proclaims the unity of the vegetative nervous system in contrast to the dualistic conception, and Ratkoczy has endeavored to draw functional conclusions on this basis with reference, at least, to the stomach. The writer will quote his work further on.

The higher efferent vegetative centers, whatever conception one may accept, are located in the hypothalamus, and to distinguish here between sympathetic and para-



Fig 10 D2001 No gross organic disease has been demonstrated in this patient's digestive tract. The peculiar regurgitation of the gastric contents into the esophagus and loud belching, especially when pressure is made on the pyloric portion of the stomach, are, I think, vegetative neurotic phenomena. In addition to this, there is a considerable residue in the stomach and duodenum at six hours yet it is not possible to demonstrate an obstructive lesion of any kind. The cecum shows non rotation. *Comment:* Figures 7 to 10 inclusive may be said to illustrate the 'nervous type' in which peptic ulcer is likely to develop. We should learn how to treat peptic ulcer preventively.

rhythmically contracts and in a purposeful direction—gradient—after having been deprived of all extrinsic innervations. The intramural plexuses are also regarded by some as a syncytium, the purpose of which is conduction, thus entirely eliminating the neuron doctrine.

Pharmacologically pilocarpine, physostigmine and choline stimulate the parasympathetic, atropine and its allies paralyze the parasympathetic. Adrenaline is said to stimulate the sympathetic division, also ephedrine, benzedrine, and cocaine. Ergotamine and ergotoxine depress the sympathetic division. Nicotine, according to Lingley, interrupts the synaptic connection between the pre-ganglionic and post-ganglionic neurons in each division of the autonomic system. The study of



Fig 11 D1949 *Diagnosis:* Appendicitis, chronic with recent acute exacerbation (surgical diagnosis following gastro-intestinal examination). The patient has had repeated attacks of nausea and vomiting, associated with more or less severe pain in the lower right abdominal quadrant. The highlights of the examination are the following: ptosis of the stomach with hypertonus and hypertonicity of the muscularis mucosae; peristalsis not increased in rhythm or speed; pylorus spastic, in fact, so much so that good filling of the duodenal bulb is only occasionally obtained by manipulation under the fluoroscope. At six hours there is considerable residue in the stomach. The cecum is fixed, and distinctly tender mesially. At 24 hours the appendix may be visualized and there is sharply localized tenderness elicited on pressure over it. The roentgen diagnosis: appendicitis chronic, with present acute or sub-acute exacerbation. The phenomena observed in the stomach are reflex in nature due to irritation of the vegetative nervous system, and quite common.

drug action on the nervous system of the digestive tract, with diagnostic or therapeutic employment in view, should be a part of our roentgenological program.

Now, to quote from Rathoczy, who utilizes the experiments of Bickel and Watanabe as well as his own roentgenological observations:

"If a dog be injected with acetylcholine, marked increase of the gastric tonus is observed. Peristalsis stops and the emptying time is prolonged.

If pilocarpine be injected, hypertonus of the stomach, increased peristalsis, and shortening of the emptying time is the result.

Adrenaline, when injected into a dog, shows

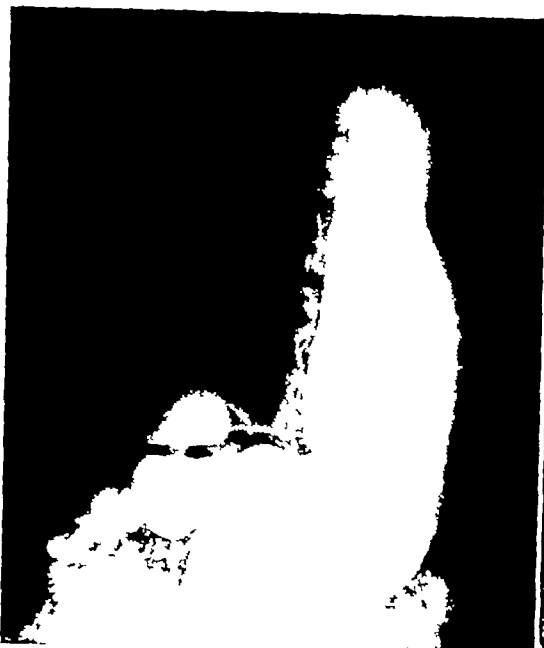


Fig 9 A



Fig 9 B

Figs 9-A and 9-B D1912 No gross organic lesion has been found in the upper digestive tract. There are peculiar vegetative nervous system phenomena such as vigorous regurgitation of gastric contents and gastric anti-peristalsis, associated with spasm of the pylorus. There is a six hour retention in the absence of any stenosis at the gastric outlet or any other gross organic lesion. Anti peristalsis is noted in the duodenum. To this may be added ptosis of the stomach and bowel and spasticity of the large bowel. *Comment* Illustrates predominantly augmentative effects evidently from both divisions of the vegetative nervous system.

Receiving stations for afferent visceral impulses are chiefly the thalamus and paleothalamus, which are regarded as the centers of "primitive sensation" and of "awareness," and stand in close relationship to the center of efferent visceral impulses, the hypothalamus, as well as the cortical sensory-motor, and visceral-efferent centers.

Concerning the innervation of the esophagus, stomach, and bowel we may make a brief statement. The esophagus is innervated by the vagus, the right and left forming a plexus about it. Sympathetic fibers come by way of the cervical sympathetic and celiac plexus to the esophagus.

The stomach is innervated by the vagus, the left one innervating the anterior and cardiac portion, the right one the posterior and pyloric portions. The sympathetic innervation is derived from the celiac plexus which, according to different authors, may be either purely sympathetic or mixed. The same is generally true of the

small bowel. In the stomach the "autonomic" system is regarded as acting by mediation of the myenteric neurons, presently to be discussed.

The vegetative system is an "extrinsic" system and is accorded only regulatory rather than initiatory function. Speaking for the stomach, there exists, in addition to the extrinsic, an "intrinsic" nervous system, which some have called the "enteric," "myenteric" or "intramural" system. The plexus of Auerbach is located between the longitudinal and the circular muscular coats of the stomach, that of Meissner below the mucosa. The conception of the majority of writers is that it consists of true neurons, effectors and sensory in nature, which form complex connections with one another and are able to act reflexly to irritation and stimuli conveyed by afferent or sensory neurons located intramurally. To be sure, some authors, like Bayliss and Starling and more recently Alvarez, have emphasized the automatism of smooth muscle which



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rhythmically contracts and in a purposeful direction—gradient—after having been deprived of all extrinsic innervations. The intramural plexuses are also regarded by some as a syncytium, the purpose of which is conduction, thus entirely eliminating the neuron doctrine.

Pharmacologically, pilocarpine, physostigmine, and choline stimulate the parasympathetic, atropine and its allies paralyze the parasympathetic. Adrenaline is said to stimulate the sympathetic division, also ephedrine, benzedrine, and cocaine. Ergotamine and ergotovine depress the sympathetic division. Nicotine, according to Langley, interrupts the synaptic connection between the pre-ganglionic and post-ganglionic neurons in each division of the autonomic system. The study of



Fig 11 D1949 *Diagnosis* Appendicitis chronic, with recent acute exacerbation (surgical diagnosis following gastro-intestinal examination). The patient has had repeated attacks of nausea and vomiting associated with more or less severe pain in the lower right abdominal quadrant. The highlights of the examination are the following: ptosis of the stomach with hypertonus and hypertonicity of the muscularis mucosae, peristalsis not increased in rhythm or speed, pylorus spastic, in fact, so much so that good filling of the duodenal bulb is only occasionally obtained by manipulation under the fluoroscope. At six hours there is considerable residue in the stomach. The cecum is fixed and distinctly tender mesally. At 24 hours the appendix may be visualized, and there is sharply localized tenderness elicited on pressure over it. The roentgen diagnosis: appendicitis chronic, with present acute or sub-acute exacerbation. The phenomena observed in the stomach are reflex in nature due to irritation of the vegetative nervous system, and quite common.

drug action on the nervous system of the digestive tract, with diagnostic or therapeutic employment in view, should be a part of our roentgenological program.

Now, to quote from Ratkoczy, who utilizes the experiments of Bickel and Watanabe as well as his own roentgenological observations:

'If a dog be injected with acetylcholine, marked increase of the gastric tonus is observed. Peristalsis stops and the emptying time is prolonged.

If pilocarpine be injected, hypertonus of the stomach, increased peristalsis, and shortening of the emptying time is the result.

Adrenaline, when injected into a dog, shows



Fig 12-A



Fig 12 B

Figs 12-A and 12-B C892 *Diagnosis* Cholelithiasis, with non functioning gall bladder according to the Graham test The stomach aside from well marked hypertonicity and moderate spasm of the pylorus, does not show any reflex vegetative phenomena *Comments* Figures 11 12 A and 12-B illustrate how gastric motor effects may be produced by afferent impulses rising from disease elsewhere in the abdomen The efferent impulses are usually augmentative in character depending on the strength of the afferent impulses

two phases of reaction first, tonic contraction, irregularity of peristaltic action, even to antiperistalsis and vomiting, the second phase follows after a few minutes and is characterized by marked hypotonus, abolition of peristalsis, and marked delay in emptying

"Atropine produces atony, abolition of peristalsis, and increased emptying time"²

In explanation of these experiments, Ratkoczy says that they are much more readily explained by the assumption of unity or synergism of the vegetative system and more logically than by the dualistic antagonistic theory "It is," he says, "much more logical to presume that the pyloric group exerts a stimulus on the entire vegetative nervous system, whereby all motor activity is increased, while atropine and its allies paralyze the entire system Adrenaline has a two-fold action, an excitatory one, followed by a paralyzing one"

To quote further

(1) "Intrathoracic double vagotomy immediately above the diaphragm produces hypotonicity and decreased peristaltic action as well as increase of emptying time These abnormalities are compensated, after a lapse of time, to a certain degree

(2) "Intrathoracic double sympathico-splanchnicotomy immediately above the diaphragm produces hypertonicity and increase of peristalsis with decrease of the emptying time. After a lapse of time these phenomena subside and leave the stomach slightly hypotonic

(3) "Extirpation of the celiac ganglion produces an immediate and marked hypertonicity and hyperperistalsis which seems to exceed even the phenomena following sympathico-splanchnicotomy

(4) "After combined double vagotomy and sympathico-splanchnicotomy the stomach is markedly hypotonic, peristaltic activity is markedly decreased and the emptying time is considerably prolonged

A compensation of these disturbances is brought about with more difficulty than if only one division has been cut."

In discussion the author says

"According to our conception mostly post-ganglionic fibers are cut with the vagus, the function of which is an augmentative one The result is naturally a decrease of all motor manifestations until other nerves with similar augmentative action (i.e., the sympathetic) take over the function of the cut pathways

To explain the results of experiments Nos 2 and 3 it is necessary to review the anatomical construction of the splanchnic As has been mentioned, the splanchnic contains mostly pre-ganglionic pathways which may be compared, according to their anatomical level, to the cortico muscular tracts The section of the

² This quotation has not been translated *verbatim* but conveys the meaning

former, accordingly, produces similar consequences as does a lesion of the pyramidal tracts in the somatic motor sphere [Thus, of course, merely in analogy] Since the pre-ganglionic pathways contain not only central augmentative impulses, but also central inhibitory impulses, the consequence of their section is increased motor activity on part of the intramural neurons excited by hematogenous stimuli, or they are stimulated by intramural reflexes. Thus hyperfunction, however, is not of long duration. The intramural ganglia cannot do without the central augmentative impulses, the pathways of which have been cut in sectioning the splanchnic. Thus the end-result of splanchnic section is the same of that of vagus section, namely, hypotonus, decrease of muscular activity. According to our conception, it is self-evident that the elimination of afferent pathways must finally result in hypofunction.

"The result of experiment No 4 cannot at all be explained on the antagonistic theory. The elimination of two antagonistic pathways should result in compensation.

"Splanchnicotomy or the extirpation of the celiac ganglion should compensate for the atonic effect of vagus section. Instead of that we see hypotonicity, hypoperistalsis, increase of emptying time reaching most extreme degrees. The result of the experiment, according to our conception, proves that the elimination of two augmentative tracts must result in a decrease of muscle activity, which is not balanced by simultaneous elimination of the inhibitory pathways running in the splanchnics."

Combination experiments, according to Bickel, quoted by Rathoczy, are the following:

(5) "Pilocarpine increases the peristaltic activity of the stomach excessively after the splanchnic has been cut.

(6) "Pilocarpine produces nearly the same reaction when the vagus has been sectioned as it does with the normally innervated stomach.

(7) "After the vagus and splanchnic both have been sectioned, the action of the pilocarpine is notably weaker.

(8) "If the vagus has been sectioned and the celiac ganglion extirpated, the action of pilocarpine is still weaker."

Comments on Experiment No 5—The explanation is the same as in experiments Nos 2 and 3, i.e., analogous to a lesion of the pyramids.

Comments on Experiment No 6—If the vagus (parasympathetic) carried only augmentative phuscs, then the elimination of these would necessarily be evident in a much greater



Fig 13 D1819 *Diagnosis* Digestive disturbances on allergic basis. Patient, aged 10 years, complains of pain in epigastrium immediately following breakfast, together with nausea and anorexia. Within from fifteen minutes to half an hour these symptoms disappear and the child feels perfectly well, but refuses further food. At the noonday and evening meals these symptoms are usually not observed. Roentgen examination reveals regurgitation of opaque drunk which is regarded as a psychical phenomena indicating patient's dislike of the barium mixture. Subsequently, stomach fills readily and smoothly, its tonus is normal, peristalsis is regular and vigorous, not increased in rhythm or speed. The pylorus is not spastic, on the contrary, somewhat relaxed. The duodenal bulb fills well and smoothly. The descending duodenum shows no abnormality in appearance and mucosal structure. One notes, however, persistent anti peristalsis, after about fifteen minutes to half an hour this ceases and the patient no longer complains of pain. The stomach empties well within the six hour period.

measure. This experiment corroborates our opinion that the vagus is only a very small part of the augmentative system, the loss of which may be comparatively readily compensated by the other parts of the system, namely, the sympathetic."

Comments on Experiments Nos 8 and 9—The results of these experiments are equally classical proofs of the unity of the vegetative system as is that of No 4. The splanchnic system, accordingly, cannot be looked upon as a simple inhibitory system.

"It is also difficult to conceive that the relatively thin peripheral vagus should be destined for the purpose of transmitting only augmentative impulses and that a system as extensive as that of the splanchnic should have a solely inhibitory function."



Fig 14-A



Fig 14-B

Figs 14-A and 14-B D2000 No gross organic pathology, important disturbances of the vegetative nervous system. These findings are well marked ptosis of the stomach and bowel, hypotonicity of the stomach, lack of vigor and decreased rhythm and speed of gastric peristalsis. There is a six hour retention in the stomach. A gastric analysis was requested on the basis of the appearance of the gastric mucosæ, achlorhydria was reported. *Comment* Illustrates the effects of debilitating general disease as well as hereditary habitus.

The author concludes that there exists only a single division of the vegetative nervous system, and drops the entire antagonistic theory, together with the parasympathetic. He states that he has been able to show that all motor phenomena in the stomach may be thus explained without having to resort to exceptions or paradox reactions or even reversed reactions.

I have quoted the work of Kiss and Ratkoczy in greater length, not because I accept their theories without further criticism as the only possible explanation of motor phenomena observed in the upper digestive tract, but rather because they are novel and tend to lead away from a multitude of contradictions and exceptions, provided their premises are true. It follows, too, that with such great diversity of opinion, it is possible only to register observations, until a satisfactory theoretical explanation is forthcoming.

As an introduction to the illustrations the writer would like to discuss for a moment visceral conditions which are felt as pain. They are primarily (1) distention, (2) contraction or spasm, (3) pain resulting from irritation of the parietal peritoneum. The latter are somatic and not primarily visceral in character. Such sensation as nausea, anorexia, burning pain, and hunger pain, as shown by Carlson, are dependent upon *motor* abnormalities of the esophagus, stomach, and the upper small intestine. These phenomena may also result from conditions higher in the vegetative nervous system, such as sea- or air-sickness, for instance, which has to do with the organ of equilibration. To emphasize the visceral motor phenomena under discussion may be due to afferent sensory effects, *i.e.*, visceral pain.

Co-ordinated vomiting is possible only if both divisions of the vegetative system are intact. Thus, the splanchnic augmenta-

tive impulses close the pylorus, and the inhibitory impulses, travelling in the vagus, relax the cardia and the cardiac opening. Augmentative impulses travelling in the vagus, produce the contraction of the stomach and the antiperistaltic effort necessary for elimination of the gastric contents. With ingested toxic substances, it is easy to see how intramural reflexes may start the mechanism.

Concerning gastro-intestinal allergy, the writer wishes to state that, having seen a number of such cases corroborated by allergic manifestations in the skin, he considers allergy a vegetative nervous system phenomenon, in that certain substances, foods, etc., are toxic to the vegetative system in some individuals at some time, and elicit more or less characteristic motor responses.

In the discussion of gastric ulcer the writer has alluded in the introduction to his own experiences as to a neurogenic factor in the causation of peptic ulcer. Many authors corroborate this opinion and have adduced a certain amount of proof for their contention, notably, Harvey Cushing, from whose essay on "Peptic Ulcer and the Interbrain," I wish to quote only one short paragraph:

"All clinicians are familiar with the facts that highly strung persons are particularly susceptible to nervous indigestion and associated ulcer. The ulcers become symptomatically quiescent or even tend to heal when patients are mentally and physically at rest, at that, symptoms are prone to recur as soon as the victims of the disorder resume their former tasks and responsibilities. Though this emotion of psychic aspect of the ulcer problem has been frequently emphasized in the past, the locus of primitive emotions and their relation to parasympathetic discharge and vagotonia has only come to be partly understood in recent years. It is proper, therefore, at the outset to disclaim any pretence toward a novel explanation of the pathogenesis of ulcer. At the same time, the hope is expressed that what will be forthcoming will serve in a measure to reconcile the several conflicting hypotheses, in my, if not all of which will doubtless contain certain elements of truth."



Fig 15 D1721 *Diagnosis (roentgen)* Chronic appendicitis with sub-acute exacerbation. Noteworthy are the high position and 'steer-horn' formation of the stomach, marked hypertonus, increased rhythm and speed of peristalsis, spastic antrum, hypertrophy of pylorus. Normal emptying time. The motor phenomena in the stomach are probably reflex to the sub-acute exacerbation of a chronic appendicitis. The important feature is the hypertrophy of the pylorus which the writer lays to persistent spasm as an etiologic factor. *Comment.* Illustrates organic changes brought about by long-continued vegetative nervous disturbances.

SUMMARY AND CONCLUSION

(1) A sketch is presented of normal and abnormal motor phenomena, roentgenologically observable in the upper digestive tract, together with some of the modern ideas and conceptions of the vegetative nervous system in its rôle of regulating and initiating such motor phenomena.

(2) Attention is directed to the idea that the vegetative nervous system plays an important part in the causation, not only of functional disturbances, but also of organic disease, particularly, of peptic ulcer.

(3) Attention is also called to the causation of digestive disturbances through the mediation of the vegetative nervous system in endocrine and allergic disturbances, and last but not least, in psychoneurotic abnormalities.



Fig 14-A



Fig 14-B

Figs 14-A and 14-B D2000 No gross organic pathology, important disturbances of the vegetative nervous system. These findings are well marked ptosis of the stomach and bowel hypotonicity of the stomach, lack of vigor and decreased rhythm and speed of gastric peristalsis. There is a six hour retention in the stomach. A gastric analysis was requested on the basis of the appearance of the gastric mucosa: achlorhydria was reported. *Comment* Illustrates the effects of debilitating general disease as well as hereditary habitus.

The author concludes that there exists only a single division of the vegetative nervous system, and drops the entire antagonistic theory, together with the parasympathetic. He states that he has been able to show that all motor phenomena in the stomach may be thus explained without having to resort to exceptions or paradox reactions or even reversed reactions.

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Coordinated vomiting is possible only if both divisions of the vegetative system are intact. Thus the splanchnic augmenta-



Fig 19-A



Fig 19-B

Figs 19-A and 19-B (Dr Coat) *Diagnosis* obstruction at gastric outlet. Ulcer niche visible in oblique projection of duodenal bulb. At six and 24 hours a large residue is seen in the stomach. Effect of tincture belladonna (atropine) there is now, on attaining the physiological limit, a relatively moderate decrease in tonus and in vigor, rhythm, and speed of peristalsis. There is definite relaxation of the pylorus, however, so that it is now possible to demonstrate the ulcer crater *en face* in the sagittal projection. (See Figs 19-C and 19-D)



Fig 19-C



Fig 19-D

Figs 19-C and 19-D See caption under Figs 19-1 and 19-B



Fig 16 A



Fig 16-B



Fig 16 C

Figs 16 A, 16 B, and 16 C D1775 *Diagnosis* Thyrotoxicosis. Metabolic rate, plus 34 per cent, clinical symptoms of thyrotoxicosis are marked, blood pressure 210/80. Digestive symptoms: lack of appetite, nausea and frequent diarrhea. The roentgen findings in the gastro-intestinal tract are typical of so-called "vagotonia," but it is more probable that the augmentative impulses of the sympathetic system are stimulated over the inhibitory, in case of the digestive tract. Noteworthy are the hypertonus of the esophagus with definite peristaltic action, practically no aerophagia, hypertonicity of the stomach: gastric peristalsis increased both in rhythm and in speed. Spastic pylorus: anti peristalsis in the descending duodenum by peritonicity of the small gut, hypertonicity of the muscularis mucosa of the stomach. Patient complains of anorexia and inability to swallow: the latter recognized as imaginary, also a feeling of fullness and pain referred to the stomach. *Comment* Illustrates typical endocrine effects on the vegetative nervous system of the digestive system, both as to afferent and efferent phenomena.



Fig 17



Fig 18

Fig 17 D1793 *Diagnosis* Normal esophagus.
 Fig 18 D1983 *Diagnosis* Relaxation of esophagus with slight spasm at cardia. Note marked aerophagia. Ptosis of stomach and bowel.

(4) With these observations in mind, it is not only possible but actually incumbent upon the physician to practise preventive therapy of peptic ulcer and other gastro-intestinal disturbances.

(5) From a scientific point of view, the old clinical pictures of "vagotonia" and "sympatheticotonia" should be discarded, as they are no longer tenable. The writer suggests the expressions "predominantly

augmentative," or "predominantly inhibitory" for the phenomena observed

(6) The study of drugs acting directly upon the vegetative nervous system with diagnostic as well as therapeutic aims is incumbent upon the modern roentgenologist

(7) Concerning the illustrations offered in this paper, it is to be emphasized that they are meant as types, and are to convey the idea of motor phenomena rather than to demonstrate pictures of organic pathology, which they may or may not show

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DISCUSSION

DR B R KIRKLIN (Rochester, Minn)
The subject of Dr Siefert's paper is broadly stated and might involve a host of problems in the physiology and pathology of the upper portion of the alimentary canal. One important phase of the theme would be the probable influence of the sympathetic nervous system in the production of gastrosplasm, and in that phase I am keenly interested.

Almost since the beginning of gastro-intestinal radiology, two varieties of gastrosplasm have been recognized—one produced by lesions of the stomach and conveniently designated "intrinsic spasm", the other associated with extra-gastric diseases or conditions and commonly called "extrinsic spasm".

Examples of intrinsic spasm include the rarely seen incisura or constriction in the plane of an ulcer, the curling of the antrum that often accompanies benign ulcer of the distal lesser curvature, and the spastic contraction and distortion of the prepyloric region that is usually associated with ulcers near the pylorus.

Spasm from extrinsic causes also assumes a variety of forms, including general increase of muscular tone, spasticity of the pylorus, transitory hour-glass contraction, travelling incisuras, crenulation of the greater curvature, antral distortion, and gross deformities of the stomach.



Fig 20-A

Fig 20-B

Figs 20 A and 20-B D1957 *Diagnosis* Duodenal ulcer. Pain in the epigastrium about two hours after meal typical hunger pain. The pain is, however, not a daily occurrence and the patient may go several weeks without it. The stomach is high and transverse. Tonus markedly increased. Peristalsis is regular not increased in rhythm or speed. Pylorus is spastic. It is difficult to visualize the duodenal bulb. No six hour retention. On the following day 1 mmg of benzedrine sulphate was given and after half an hour an opaque drink was administered. The pyloric sphincter was found to be definitely relaxed and, peculiarly the tonus and the peristaltic activity definitely increased. The film is shown to demonstrate this action of benzedrine. The duodenal ulcer was demonstrated subsequently by means of showing the mucosal pattern.



Fig 21-A

Fig 21-B

Figs 21 A and 21 B D1790 *Diagnosis* Organic obstruction of gastric outlet, probably by a duodenal ulcer or ulcer scar. Noteworthy are marked hypertonus, deep vigorous peristalsis which, while not increased in rate, impresses one as obstruction peristalsis since the stomach occasionally dilates and there is absence of peristaltic activity. The duodenal bulb may be seen but it is very small and distorted. At six hours there is a very large residue in the stomach. At 24 hours the stomach is empty. Benzedrine sulphate, 30 mmg was given and one-half hour later the stomach was re-examined. There is no relaxation of the gastric outlet but again there is increased tonus and increase in peristaltic activity.

Comments on Figs 19-A to 21-B inclusive These illustrate the effects of two drugs used commonly in roentgen diagnosis. Of the two in the writer's opinion benzedrine is the more satisfactory, although there is the disadvantage that it is unsafe to use in cardio-vascular disease particularly hypertension.

The relaxing effects of atropine in the author's experience are not so satisfactory at least not with moderate dosage. The writer has observed absolutely no effects on a spastic colon for instance with long-continued administration of atropine and its allies particularly hyoscine.

NON-CARCINOMATOUS TUMORS OF THE STOMACH

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THE relatively infrequent non-carcinomatous gastric tumors vary widely in gross morphology and associated roentgen manifestations. Benign tumors are frequently recognized (4), the others are seldom diagnosed roentgenographically. When a carcinoma or a benign tumor is simulated, the confusion is not so serious, if all gastric tumors are considered at least potentially malignant, and, when possible, subjected to microscopic proof. However, under a diagnosis of polyposis, hypertrophic gastritis, benign ulcer, or syphilis, surgery or irradiation may be withheld. Also sarcoma, still resectable, may resemble frankly inoperable gastric carcinoma or abdominal tumor (9).

It may then be justifiable, in spite of the generally acknowledged absence of reliable roentgen signs, to survey these variegated lesions together for any predilections, roentgenographic or clinical, which will justify suspicion of their presence.

Benign tumors of the stomach have been considered rare, but recent literature has established that they are not as uncommon as previously supposed. Careful roentgenologic and pathologic studies have lifted these lesions from comparative obscurity.

The incidence of benign tumors has been found to be 1.3 per cent by Eusterman and Senty (11), less than 2 per cent by Kirklin and Weber (quoted by Rigler and Ericksen, 32), about 1.5 per cent by Lockwood (24), and recently Rigler and Ericksen (32) put the figure at approximately 11 per cent. Reimets (31) made a careful examination in 200 consecutive postmortems and found small single or multiple gastric leiomyomas in 17 per cent, demonstrating that a meticulous search raised the pathologic incidence considerably.

Benign tumors had a predilection for the pylorus in 69 per cent of the cases, 25 per cent being situated in the body and 5 per cent in the cardia. The Balfour series (2) of 58 cases of benign tumor of the stomach is probably a fair representation of predilective sites. Of 14 single adenomatous polyps, one was on the anterior wall, four on the posterior wall in the body, and nine on the posterior wall in the prepyloric region. In four cases of adenoma, three were near the pylorus and one on the anterior wall near the mid-stomach. Under the general group of fibromas, myomas, fibromyomas, adenomyomas, and myxofibromas, 10 tumors were situated near the pylorus, two in the antrum, two in the mid-gastric region, and one in the cardia.

In our case of gastric tuberculoma the lesion was on the greater curvature in the prepyloric region (Fig 1).

Overfilling of the stomach with the barium was the commonest cause of the failure to make a diagnosis. The rugal pattern was obliterated and often a tumor of relatively moderate size was hidden. Adequate manipulation and palpation, pressure on the stomach, and films made during roentgenoscopy gave better visualization and localization. Small defects of the anterior and posterior walls of the stomach were brought out by films of heavy penetration (32).

The vague and protean symptoms of these tumors have been the cause of the dismissal of many patients as being neurotic or having a gastric disturbance of a reflex nature. However, recent data have shown us that there are certain signs and symptoms which are at least strongly suggestive of benign gastric tumor. The manifestations are dependent upon the size and location of the tumor and anemia or ulceration. Pedunculation of the tumor

Because spasm from extrinsic sources resembles that caused by gastric disease, interferes with inspection of the mucosal relief, and hampers filling and visualization of the duodenum, it has always received solicitous attention, and various measures—including the administration of antispasmodics—have been employed to prevent or remove this handicap.

Through all the years it has been assumed that the chief causes of extrinsic gastropasm are duodenal ulcer, disease of the gall bladder, and chronic appendicitis, and that other intra-abdominal affections occasionally are responsible. That such diseases may reflexly, through the autonomic nerves, give rise to spasm cannot be denied for the association has been observed repeatedly. Besides, the stomach is notoriously sensitive to pathologic conditions elsewhere and many diseases that do not implicate the stomach organically are attended with gastric symptoms, some of which are logically attributable to reflex spasm.

But of late I have become convinced that the most common cause of the spastic manifestations so often encountered at roentgenoscopic examination is not disease of some organ other than the stomach but certain emotions of the patient, particularly fear and anger. This belief is in consonance with the accepted fact that emotional states may markedly affect gastric tone, secretion, and motility.

At all events, when the patient under roentgenoscopic examination is apprehensive or vexed, he assumes a defensive attitude. His abdominal muscles are tensed and the resulting increase of intra-abdominal pressure pushes the stomach upward and deforms it. Frequently such deformities have been mistakenly attributed to gastropasm, but after the patient has been persuaded to relax his abdominal muscles, really spastic manifestations are often evident. Gastric tone is abnormally increased, the stomach is drawn up under the

ribs and sometimes distorted, and the pylorus remains obstinately closed. Consequently, the necessary manipulations of the stomach cannot be carried out and it is difficult or impossible to exhibit the duodenal bulb.

Even slight degrees of vexation or alarm on the part of the patient may be sufficient to induce such spasm. For example, I recently had a patient—a woman—whose stomach was so spastic that I could not examine her. On inquiry I learned that my assistant had grasped her hand abruptly when she entered the room and led her to the screen apparatus instead of merely directing her where to stand. Her resentment at this seeming indignity was responsible for her intractability.

Again, a few days ago I examined a man without difficulty but asked for a re-examination to confirm the findings. Next day when he appeared for the second examination, his stomach was spastic and unmanageable. When he was questioned, he admitted that the request for re-examination had alarmed him because he regarded it as an indication that he had a grave affection of the stomach.

I have found, also, that when I am irritable my patients acquire my mood and become recalcitrant!

So certain am I that emotional stress induces gastropasm that in my screen room procedure many precautions are taken to avoid vexing or alarming patients. Attendants are required to speak in low and pleasant tones, to shun any appearance of haste or excitement, to keep their hands off patients, and to treat them with all respect and dignity. During the examination I try with brief but friendly conversation to gain the patient's confidence and promote his serenity.

By these measures my work has been made easier, re-examinations have diminished, and accuracy in diagnosis has been approached more closely.



Fig 2 A



Fig 2 B

Fig 2 Case 1 (A) Infiltrative lymphosarcoma, most pronounced in the proximal half of the stomach. The fundus, not directly involved, is compressed by the adjacent flexible tumor (B) Supine view showing greater distention of the uninvolved fundus and of the remaining involved proximal part of the stomach. On other films a preserved interval between splenic flexure and stomach outlined the diffusely thickened walls of the stomach.

lesions occurring before the fourth decade, the likelihood of sarcoma is significantly increased.

A sex predilection appears established by Askey's (1) 70 per cent males in 335 reviewed cases.

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The duration of symptoms is quite variable. Balfour's series (4) gives an average of 18 months with a maximum of 9 years. Others record long continued symptoms or repeated similar attacks (30, 16, and 7). Malignant degeneration of tumors, originally benign, or exceptional low malignancy and slow growth, may be a factor.

Gastric sarcomas vary widely in histologic type, gross morphology, and roentgen findings. They have been classified morphologically as those growing intramurally, endogastrically and exogastrically, a grouping which has definite bearing on roentgen manifestations.

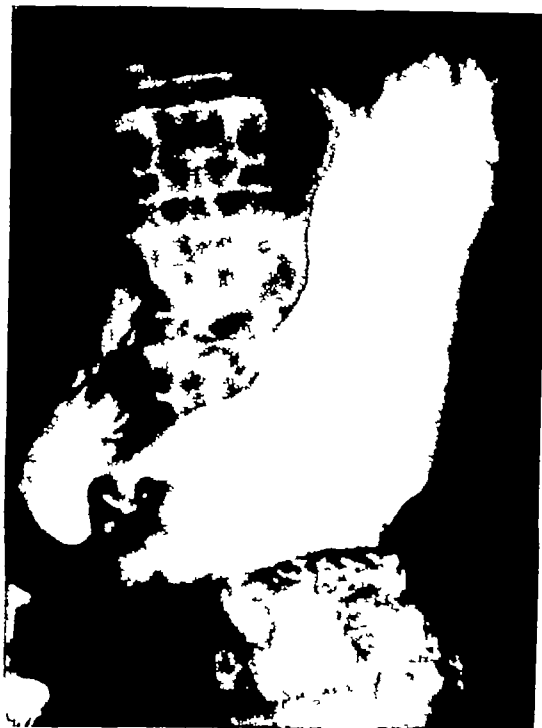


Fig 1

Fig 1 Tuberculoma, with sharply localized smooth rounded encroachment upon the gastric lumen. Resembles benign tumor or endogastric sarcoma. There was far advanced, pulmonary tuberculosis.

has been found responsible for intussusception into the duodenum, strangulation, the syndrome of intermittent gastric ileus of the mechanical type (26). Of the group 10 per cent had pyloric obstruction (14).

Gastro-intestinal hemorrhage and anemia may be the only and the most important signs and symptoms in many cases (14). Many patients had some form of dyspepsia. Judd and Hoerner (20) found this to be true in 60 per cent of their cases, others simulated peptic ulcer, and vomiting was the predominant symptom in some. Hematemesis and achlorhydria were of note in polyposis of the stomach (22 and 19).

There was practically unanimous agreement that anemia of the secondary type was the most common sign. Occult bleeding was declared greater in benign gastric tumor than with peptic ulcer, while gross hemorrhage was not rare. Some of these

lesions were entirely symptomless. In the series of Balfour and Henderson, the youngest patient was 8, the oldest 69, and the average age was 46 (2).

The recognition that most benign tumors of the stomach are circumscribed filling defects, usually situated on the gastric walls, leaving the curvatures regular and free for the peristaltic movement, has been a basic aid to their diagnosis. The rugae are obliterated in the area of the tumor, but immediately surrounding the tumor they are practically normal in pattern. Benign tumors do not reveal a niche, incisura, or any other evidence of spasm. Gastric retention is rare except when the lesion is at, or near, the pylorus.

When polyposis is extensive, there are small indentations along one or both curvatures. If the polyps are closely set or the barium too thick, the mixture will not penetrate to the gastric wall and the appearance will be broken and irregular. The differential diagnosis should include simple hypertrophy, food particles, gas in the transverse colon, crenulation of the greater curvature, gastric carcinoma, and hair ball (22 and 32).

Syphilis of the stomach results in lessened flexibility and mobility, contraction of varying degree, and absence of peristalsis. The pylorus tends to be gaping. There is no palpable mass and the patient is usually in good general condition compared to the extent of his gastric pathology (28).

- Malignant tumors of the stomach, excluding carcinoma, are necessarily mesoblastic, fundamentally sarcomas. Ewing's (15) widely quoted estimate that these are 1 per cent of gastric tumors is generally accepted. Individual series vary moderately from this figure.

Sarcomas have occurred at all periods, from early childhood to advanced age (17). Balfour and McCann's (4) reported average age of 43 years for sarcoma as compared with 61 for carcinoma appears reasonably typical. Cheever's (9) series of lymphosarcoma having an age average of 53.5 suggests a later incidence for that type. In



Fig 2-A



Fig 2-B

Fig 2 Case 1 (A) Infiltrative lymphosarcoma most pronounced in the proximal half of the stomach. The fundus, not directly involved, is compressed by the adjacent flexible tumor (B) Supine view showing greater distention of the uninvolved fundus and of the remaining involved proximal part of the stomach. On other films, a preserved interval between splenic flexure and stomach outlined the diffusely thickened walls of the stomach.

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Ewing (15) classifies them pathologically as

- (1) Spindle-cell myosarcomas
- (2) Lymphomatous tumors
 - (a) as a part of the leukemic process,
 - (b) in gastro-intestinal pseudoleukemia,
 - (c) as part of a general lymphosarcoma,
 - (d) in the form of localized lymphosarcoma
- (3) Miscellaneous sarcomas, variously described as alveolar, mixed cell, or angiosarcoma, or myxosarcoma

One would infer that in Ewing's group of spindle-cell myosarcoma there would appear tumors named elsewhere as spindle-cell sarcoma, fibrosarcoma, some of the "round-cell" sarcomas, and some of the angiosarcomas

Two tables of incidence of the varieties of gastric sarcoma will illustrate both their relative frequency and the terminology under which they are found

Balfour's series of 45 cases (4)

Lymphosarcoma	32
Fibrosarcoma	5
Myosarcoma	3
Angiosarcoma	1
Perithelial angiosarcoma	1
Spindle-cell sarcoma	1
Sarcoma	6

D'Aunoy's and Zoeller's survey (10)

Lymphosarcoma	39
Round-cell sarcomas	24
Spindle-cell sarcomas	7
Fibrosarcomas	7
Round- and spindle-cell sarcomas	2
Leiomyosarcomas	2
Fibromyxosarcoma	1
Carcinosarcoma	1
Undifferentiated sarcoma	1
Sarcoma originating in reticulo-endothelial cells	1
Fibroneurosarcoma	1
Fibromyosarcoma	1
Mixed-cell sarcoma	1
Angiosarcoma	1
Fibrochondrosarcoma	1
Mixosarcoma	1
Polymorphous-cell sarcoma	1

LYMPHOBLASTOMAS

Lymphoblastomas, excluding the benign irritative hyperplasias, may be classified after Ewing (15) as follows

- (1) Lymphomatous group, including lymphatic leukemias, pseudoleukemias, and malignant lymphocytoma
- (2) Reticulocytomas, including myeloid leukemia, Hodgkin's disease, and large round-celled sarcoma
- (3) Primary endothelioma

It appears best, in view of the pathologic confusion in this field, to consider them as lymphoblastoma. If one may add to primary lymphosarcoma the other clinically malignant lymphoblastomas, then this type of lesion, relatively radiosensitive, will include more than half of the non-carcinomatous malignant tumors of the stomach. This appears permissible for the present purpose although it may include lesions not technically sarcomas

These arise, usually multicentrically, in submucosal lymphatic tissue. They involve the submucosa first, spreading to mucosa muscularis, and, sometimes, later, the serosa. The stomach may be extensively or locally involved. The gastric lesion may be part of a generalized involvement, in which case superficial glands are often available for biopsy, or the disease may be primary in the stomach. These lesions are primarily intramural though there may be an associated endogastric or exogastric mass.

Varied types of deformity are seen roentgenographically. A diffusely infiltrating form is characterized by a moderate decrease in caliber, thickened walls, diminished flexibility and peristalsis, and enlarged or distorted rugæ (33). This may be extensive or local (Fig 2).

Such lesions are readily missed especially if represented only by a local stiffening of walls (33), or when limited to the cardiac half of the stomach. Here, a moderate constriction with prominent rugæ may be attributed to pressure from adjacent organs. A soft mass is not readily palpated, and sluggish or absent peristalsis is not remarkable. Thickened walls may register only as a preserved interval between the stomach and adjacent colon, or a pressure deformity of the latter (Case 1).

Such diffuse lesions are particularly in keeping with primary lymphosarcoma.

Multiple lobulated endogastric masses provide another type of lymphoblastoma. These masses are outlined by a reticulum of barium filling the interlobular crevices (33). Such manifestations suggest the less invasive forms, such as leukemia (25).

Another form is a rounded or irregular local mass encroaching upon the gastric lumen (5, 6, 11, 17, 29, and 33). Penetrative niches may occur in a large intragastric mass (6, 8, and 11). Rugal enlargements and distortions may overlie the diffuse lesions or be adjacent to ulcerative or massive lesions (5, 29, and 33).

Usually, constrictive lymphoblastoma has been said to occur only in the prepyloric regions (33), elsewhere, the delicate connective tissue framework of these tumors appears not to encourage this deformity (9). At least one exceptional midgastric encircling lymphosarcoma has been reported (21). Irregularity of the prepyloric constriction is stressed. Flexibility of the lesion is partially preserved. Peristalsis may or may not be seen and mass may or may not be palpable at the deformity. Shallow ulceration or even perforation may occur but a demonstrable niche is not featured (5, 33, and 18).

ROUND-CELL SARCOMAS

These are confused groups—D'Aunoy and Zoeller found them the second largest class reported. Balfour discarded three such cases as being carcinoma, leaving none so listed in his series. Ewing concludes that small round-cell sarcomas are, with rare exception, either lymphosarcoma or small round-cell carcinoma. The large round-cell sarcomas he divides among endotheliomas, tumors of lymphoid cells, carcinomas, and sarcomas of which the cells are not strictly round. This, if essentially correct, would accentuate still further the predominant position of lymphoblastoma. It would be natural that round-cell sarcomas tend to infiltrate intramurally (30) and resemble lymphosarcoma.

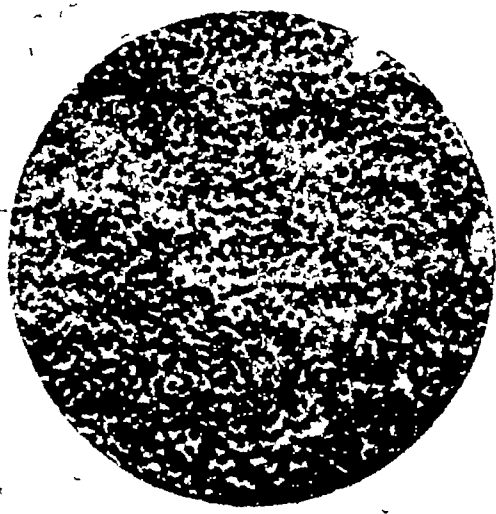


Fig 3 Case 1 Lymphoid cell lymphosarcoma

MISCELLANEOUS SARCOMAS

Concerning these, Ewing says, "None of these histologic features deserve special recognition as a separate variety of gastric tumor." No gross morphologic or roentgen characterization of this group can be attempted here.

OTHER NON-LYMPHOBLASTIC SARCOMAS

Most of these tend to grow either endogastrically or exogastrically instead of intramurally. In either case they may be pedunculated and mobile. Histologically, they may be fibro-, neurofibro-, myo-, or angiosarcoma, and appear to correspond to Ewing's spindle-cell myosarcoma group. They are radioresistant as a rule, and are more likely to be operable than their size would indicate (4 and 9), due to their non-invasive, sharply circumscribed character.

Growing endogastrically, they produce spheroidal or rounded defects, sharply demarcated from the adjacent uninvolved stomach (9, 36, and 7). Necrosis and hemorrhage are common, frequently with roentgenographic demonstration of a barium-filled button (Fig 7) or deep penetrative niche (17 and 36) at the surface of the lesion.

Growing exogastrically, palpable masses, usually large, displace or distort the stomach (36 and 30). These may grow from the anterior or posterior walls and are particularly prone to extend between the layers of the gastro-hepatic or gastro-colic omentum (9). Such lesions are prone to hemorrhagic or cystic degeneration. Leiomyosarcoma, particularly, may be of the dumb-bell type, growing both intra- and exogastrically (36 and 23).

TYPES OF GASTRIC DEFORMITIES

One may list the types of gastric deformities which have been produced by non-carcinomatous tumors, considering other lesions which they may simulate

Isolated rounded endogastric masses

- Adenoma or polyp
- Carcinoma *in situ* (5)
- Benign mesoblastic tumors, as,
 - fibroma
 - neurofibroma
 - leiomyoma
- Non-lymphoblastic sarcoma, as,
 - fibrosarcoma
 - neurofibrosarcoma
 - leiomyosarcoma (Fig 6)
 - angiosarcoma (Fig 7)
- Lymphoblastoma

The small rounded endogastric tumors, without alteration of peristalsis or of the adjacent gastric wall, can be accepted as positively benign only by operation and microscopic proof. Their appearance is not distinctive between the various types, all being potentially malignant. Hemorrhage, with this type of lesion, is not distinctive but the barium-filled niche speaks for non-lymphoblastic sarcoma, especially if associated with repeated hemorrhage (7). These features were used successfully by one of us (D R L) to diagnose a leiomyosarcoma (Fig 7). The surface of the tumor may be "scalloped" in either the benign or malignant forms.

Excepting lymphoblastoma and carcinoma, tumors should not deform the adjacent part of the stomach or inhibit its peristalsis. An adjacent or general rugal hypertrophy speaks for the radiosensitive

lymphoblastoma (29). The other types are radioresistant and not appropriate for the test of irradiation.

Polypose manifestations, local or general

- Polyposis
- Carcinoma
- Lymphoblastoma

The individual nodes of a benign polyposis should usually be smaller and more regular than those of lymphoblastoma or carcinoma, carcinoma should be more readily palpable, more rigid than either, and inhibits peristalsis. The response to moderate irradiation should identify lymphoblastoma (33).

Rugose manifestations, local or general

- Benign hypertrophy
- Rugal hypertrophy or ruga like scars about benign ulcer
- Infiltrative carcinoma
- Lymphoblastoma (Fig 4)

Benign rugal hypertrophy, local or general, may closely resemble lymphosarcoma. Both reduce peristalsis and flexibility (33 and 35). Lymphoblastoma is more apt to produce a moderate general decrease in caliber but may enlarge it grossly (29). The concentric scarring or irregular rugal deformities associated with benign ulcer and the meniscus deformity about carcinomatous ulcer are usually reasonably characteristic but may be simulated by lymphoblastoma (5). Occasional rugal types of carcinoma may resemble lymphoblastoma or benign hypertrophy (12). The test of irradiation may be useful.

Diffuse decrease in caliber, local or general

- Scirrhus carcinoma
- Syphilis
- Lymphoblastoma

Rigidity, a palpable mass, marked decrease in caliber, and absence of peristalsis would indicate carcinoma. Partial preservation of flexibility and peristalsis with rugose manifestations and moderate decrease in size suggests diffuse lymphoblastoma. No palpable mass, some flexibility, and absent peristalsis favors the diffuse type of syphilis (28).

While the decrease in size of the stomach is usually moderate (33 and 18), it may be extreme (18)

Irregular endogastric mass

- Carcinoma
- Lymphoblastoma
- Round-cell sarcoma
- Other non-lymphoblastic sarcomas

Any preserved flexibility or peristalsis may favor lymphoblastoma. The general bulkiness of sarcoma (11, Grier in discussion) may help. Again it is important to remember that large sarcomas may be removable (4 and 9). An apparent gross irregular intra-gastric growth may resolve roentgenographically under adequate pressure into voluminous rugal enlargement (Fig 4). This speaks for lymphoblastoma.

Prepyloric constriction

- Carcinoma
- Benign ulcer, particularly the saddle variety with spasm
- Syphilis
- Inflammatory constrictions and retractions of perigastric origin
- Spasm, reflex
- Lymphoblastoma

The rigid, irregular, palpable lesion with absent peristalsis, anacidity and obliterated rugæ should be the usual carcinoma. The contracted prepylorus of niche-less ulcer should be not entirely inflexible, have visible rugæ and be associated with gastric acidity. The reflex spasm may be decreased or removed by belladonna. History of upper abdominal infection or surgery may help with the perigastric inflammatory constriction. Absence of palpable mass, smooth annular constriction, some flexibility, absent local peristalsis, minor symptoms, and a positive serology speak for syphilis and justify the therapeutic test.

All that can be sought is some reason to suspect the occasional prepyloric lymphoblastoma. A marked irregularity, partly preserved flexibility, and peristalsis, and evident adjacent rugal hypertrophy may suggest that disease. Severe pain would suggest either ulcer or lymphoblastoma. A definite niche appears less likely than shall-

low ulceration in lymphoblastoma of constrictive type (5 and 33)

PRESSURE DISPLACEMENTS AND
DISTORTIONS OF THE STOMACH

Non-gastric masses include the following

- Tumors or enlargement of the spleen
- Tumors of the kidney, pancreas, adrenals, liver or retroperitoneal structures
- Massive metastasis from a concealed primary tumor
- Inflammatory masses
- Exogastric sarcoma
- Massive metastasis from an inconspicuous gastric lymphosarcoma (9)

The first group, too varied for complete listing, is an every-day occurrence. The occasional exogastric sarcoma should be remembered. Its connection with the stomach may be disguised by a pedicle which makes it mobile. On the other hand the sarcoma may be the dumb-bell type or cause such sharply localized pressure that a roentgen conclusion of endogastric or exogastric growth is difficult. Most exogastric sarcomas will be of non-radio-sensitive varieties but may be operable though large. The stomach should be searched for signs of a gastric infiltration from which to suspect exogastric mass or metastatic lymph glands of the radio-sensitive gastric lymphoblastoma.

COMMENT

A sharply circumscribed rounded endogastric mass bearing a demonstrable ulcerative niche may be considered probably a radioresistant non-lymphatic sarcoma. Such lesions without niche and not too large may be considered presumably, but only presumably, benign. Otherwise no roentgen signs even presumptive in value have been encountered by which to recognize non-carcinomatous tumors of the stomach. Only grounds for suspicion are found otherwise.

The radiosensitive lymphoblastoma should be suspected in lesions, rugose polypose, diffusely or irregularly infiltrative, and in cases in which preservation of

flexibility or peristalsis are otherwise not to be expected. The test of irradiation is to be considered in such cases. Study of the blood, roentgen examination of the chest, and thorough examination of superficial lymphatic glands is indicated because of the possibility of systemic lymphatic disease.

Methods of irradiation have not been discussed here. Holmes has warned that disastrous necrosis may be produced in lymphoblastoma (8). Pack and McNeer (29) have used intensive fractional irradiation with success in lymphosarcoma (29).

Upper abdominal mass displacing the stomach will occasionally be due to gastric sarcoma. The radiosensitive lymphoblastoma is suggested by associated infiltrative deformities in the stomach. The radioresistant sarcomas are possible when intrinsic gastric deformity is absent or is of the circumscribed rounded type.

An exceptional bulky tumor of the stomach suggests sarcoma.

Gastroscopy, when its possibilities are fully exploited, may be a great aid in the identification of gastric tumors.

CASE REPORTS

Case 1. A white married female (L. C.), aged 46 years, entered the hospital on Nov. 22, 1930, complaining of loss of ten pounds in three months, weakness, a questionable swelling in the left upper quadrant for one month, and more recently a dragging sensation in the abdomen while in the standing position. Appetite had been good, and stool habits normal. Some examiners denied, and others felt, a mass in the left upper quadrant. It was described as pulsating, freely movable, and having a rubbery edge. The red blood cell count was 4,300,000, hemoglobin 50 per cent, and white count 12,000 with normal differential. Roentgenographically, the stomach was low, vertical, and hypotonic, with no filling defect noted. There was some stasis in the duodenal cap. Peristalsis and mobility appeared not remarkable. The upper half of the stomach

appeared constricted in the prone position but expanded to practically normal in the supine (Fig. 2). A barium enema demonstrated a defect near the splenic flexure, suggesting external pressure. Surgery disclosed a sarcoma of the stomach involving all the stomach from two inches below the cardia, and also the anterior pole of the great omentum. The stomach was resected and the patient died the following day.

The specimen of stomach examined pathologically was 21 cm. in length and 11 cm. in diameter at the fundus. The outer surface of the stomach, especially the proximal two-thirds, was covered with a gray tumor growth. The wall was greatly thickened, being 3 cm. in the fundus. The microscopic diagnosis was lymphosarcoma of the stomach. Dr. Newton Evans, in review, considers this to be of lymphoid cell type (Fig. 3).

Comment—Infiltrative type of lymphosarcoma. Contributing to the failure to recognize it roentgenologically were the following: marked flexibility of the gastric walls even at the site of greatest infiltration, preservation of peristalsis throughout, too ready acceptance of external pressure as a cause for the manifestations observed. It is noteworthy that the growth was described as "covering" the stomach. We hope that so classical an infiltrative lymphoblastic lesion would not be missed now.

Case 2. A white married female (M. B.) aged 63 years, had dull constant pain, unrelated to meals, in the left upper quadrant for ten months. In the past ten weeks there had been a swelling of this region and the pain had become more severe. Weakness, anorexia, and loss of 15 pounds were noted in the four months before entrance. On physical examination there was noted a large, firm, sharp edged mass in the left upper quadrant running obliquely across the umbilicus. The mass moved with respiration and was tender to pressure. The liver was not palpable. There was no free acid, and the combined acidity was 12 by the Ewald test-meal. There was 4 plus occult blood in the stools.

The red blood cell count was 3,780,000, the white count 18,000 with 90 per cent polymorphonuclears. The roentgenologic

There was extension along the dome of the diaphragm, the left lobe of the liver, and the gastro-splenic ligament. Microscopic-



Fig 4 1 Case 2 Lymphosarcoma. Irregular encroachment on the lumen of the stomach coarsely rugose but because of its flexibility and hard adjacent extragastric mass interpreted as pressure distortion.

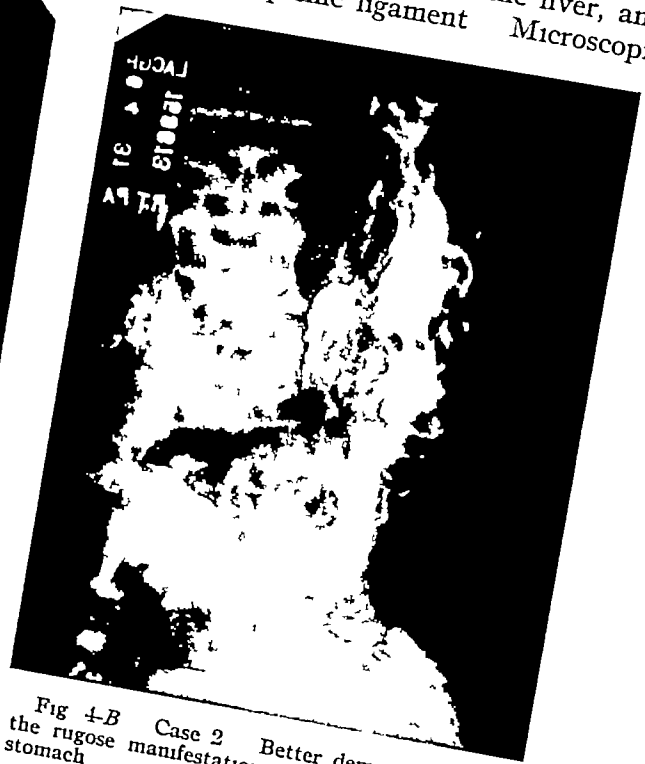


Fig 4 B Case 2 Better demonstration of the rugose manifestations and flexibility of the stomach.

examination demonstrated poor filling of the upper half of the stomach, the barium passed rapidly into the duodenum (Fig 4). On palpation there was noted a hard, well-defined mass lying medially and extending posteriorly to the body of the stomach. The incomplete filling appeared to be due to pressure defect of the tumor rather than to a primary gastric tumor. At surgery a large mass occupied the upper left half of the abdomen. There were extensive dense adhesions. The stomach was smooth and the walls greatly thickened. The patient died the following day.

Autopsy disclosed a white glistening gastric neoplasm which infiltrated the walls and involved the entire stomach except the cardiac portion and the pyloric ring. There were no ulcerations of the mucosa.

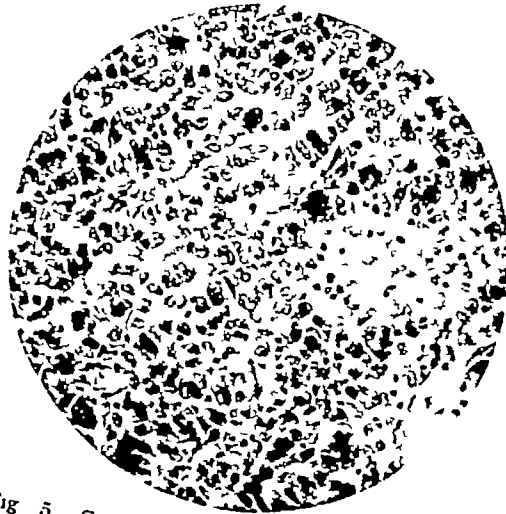


Fig 5 Case 2 Reticulum cell lymphosarcoma.

cally the tumor was a lymphosarcoma of the stomach. Dr N. Evans reviewed this material and concluded that the lesion was of the reticulum cell type (Fig 5).



Fig 6 Case 3 Angiosarcoma, endogastric and exogastric



Fig 7 Case 4 Leiomyosarcoma endogastric peristalsis throughout, crater of ulcer demonstrated

Comment—Infiltrative lymphosarcoma with marked extragastric extension. Less ready acceptance of rugose manifestations and distortion of the stomach as due to pressure would now give grounds for suspecting lymphoblastoma. It is noteworthy that the exogastric mass was hard to palpation while the stomach was quite flexible.

Case 3 A white male (F B), aged 51 years, entered the hospital first in June, 1931, in a restless, non-co-operative state bordering on a dementia. The patient apparently had been well until two weeks before entrance when he began to have pains in his abdomen, loss of appetite, sensation of fullness, nausea, and occasional attacks of vomiting. There was also some loss of weight and strength. Physical examination was essentially negative. The Ewald test-meal disclosed free HCl of 4 and a combined acidity of 7. The entering blood count was 1,900,000 red blood cells, hemoglobin 45 per cent, white cells 15,400, with 82 per cent polymorphonuclears. A series of blood transfusions finally brought the red count up to 3,500,000 and the

hemoglobin to 60 per cent. The stools were tarry. Roentgenographically, the stomach revealed a large rounded defect in its mid-portion which gave the impression of extrinsic pressure from the anterior side (Fig 6). Peristalsis passed throughout the stomach. There was no retention. The colon was negative. Surgically, there was an apparently benign tumor of the anterior and superior surface of the stomach, predominantly angiomatous. The mass was about $3 \times 4 \times 2$ inches. Two ulcerated areas showed the site of hemorrhages into the stomach. Vascularity about the stomach was greatly increased. Attached to this mass was a pedunculated nodule about 4 cm in diameter composed of soft gray tissue and somewhat hemorrhagic. The mass was excised. Pathologically, two ulcerated areas, 2 cm in diameter, were observed. Subadjacent to the mucosa was a large soft mass about 8 cm in its greatest diameter composed of very soft gray tissue resembling sarcoma. Microscopically, the lesion was an angiosarcoma of the stomach. In a recent review of the microscopic section, Dr. Newton Evans

was of the opinion that the lesion was an angioendothelioma which would be essentially the same as angiosarcoma. However, the possibility of an atypical carcinoma was to be considered. The patient re-entered the hospital a year and a half later complaining of swelling of the abdomen and obstipation for two weeks. Physical examination revealed a prominent abdomen with bulging in the flanks and a large indefinite mass in the mid-line. The red blood cell count was 4,400,000 and hemoglobin 60 per cent. An abdominal paracentesis was done and 3,000 c.c. of bloody fluid was obtained. The patient was discharged to the County Infirmary as an inoperable case.

Comment—While the description of gross pathology is not entirely clear, the lesion appears to be of dumb-bell type, the extrinsic mass serving to disguise the endogastric protrusion. The local persistence of peristalsis indicates a non-infiltrative lesion such as may be expected from non-lymphoblastic sarcoma, including myo-, fibro-, and at least some angiosarcomas. The niche, if demonstrated, would have spoken against a benign lesion and for sarcoma.

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DISCUSSION

DR ROBERT S STONE (San Francisco) Dr Carter's paper is of such a complete nature that it is one we will all want to have for reference. I wish to commend Dr Carter on the method of attack which he has taken on this problem, a method which is all too infrequently taken by us as roentgenologists. Due to our previous medical training and the influence of the medical colleagues who surround us, we nearly all attack problems from the pathologist's or clinician's standpoint. Dr Carter has taken the true method of the roentgenologist, namely, he has taken up the various deformities and discussed what lesions might cause each type of deformity.

After all, that is our daily problem. We are not confronted with the problem of diagnosing the pathologic condition from the microscopic slide or the bedside findings. We must diagnose the pathologic condition from the deformities that we see on the films or fluoroscopic screen. I wish that more of us would take Dr Carter's line of attack on the problem when presenting a paper dealing with diagnosis.

He has covered the problem so thoroughly that there is little left to be said in the way of discussing the various lesions. I would like, however, to say in one or two words something about the prepyloric spasms which he mentioned briefly in his paper.

It brings up the problem which was brought up previously by Dr Kirklin, namely, re-examination of these patients and the cause of the spasms.

We have had a number of cases in which, on re-examination without medication the spasm has disappeared. I am, rightly or wrongly, considerably impressed by the fact that in the re-examination with belladonna, atropine, benzadrine sulphate or any of the antispasmodics, it is not a question of the antispasmodic at all but of simply getting the patients back into the fluoroscopic room after they have been there once and know what it is all about. Maybe it is a question also of their being treated more gently the second time than

they were the first time, and therefore the patient does not have the same reaction.

On the other hand, there are cases in which operations revealed no evidence of disease and yet in which the spasm was not relieved either by repeated examinations, even at some months' interval, or by the administration of any of the antispasmodics. I think that neither repeated examinations nor the administration of antispasmodics necessarily establishes whether some of these defects in the prepyloric region are caused by an actual organic lesion or by a localized spasm.

This holds particularly, I believe, for cases of gall-bladder disease. We are inclined to think at times that the deformities seen in such cases are due to adhesions and when the surgeon opens the abdomen and says he finds some adhesions between the gall bladder and the duodenum, we say, "Well, that must have been the cause of the deformity." But if you look back on your films you find your deformity was nowhere near where the adhesions were. The deformity was in the prepyloric region of the stomach and there was no pull of the adhesions on that point.

One other point I would like to emphasize is the differential diagnosis between polypoid tumors. Of course, if the stomach wall is rigid around a polypoid tumor, we have no hesitation in considering it as a malignant lesion with invasion of the stomach wall, but if the stomach wall is not rigid and peristalsis still passes through, we are inclined to diagnose it as benign polyposis.

I wish to emphasize what has been pointed out before, namely, that with polypoid lymphosarcoma in the early stages there may not be any invasion of the muscular wall and there may be absolutely no rigidity. So we come to the point that Dr Carter made—that we must not consider these tumors as benign until they have been proven to be so. We have to accept them as malignant.

There is one other point which Dr Carter made that I think is of great significance. That is, if you are able to demon-

strate an ulcer niche in the polypoid tumor, it is much more likely to be a malignant tumor than if you do not find any such niche on the polypoid growth Dr Templeton in his scientific exhibit demonstrates one case in which the appearance of niche was caused by a dimple in a benign polyp

Let me again congratulate Dr Carter on his thorough and lucid presentation of this subject from the roentgenologist's point of view

DR LEO G RIGLER (Minneapolis, Minn) I would just like to say a word or two about the incidence of benign tumors of the stomach I think the 11 per cent figure which Dr Carter mentioned is my responsibility, more or less, and I would like to emphasize it again

We have looked over our autopsy figures very carefully, as has Stewart, and it is amazing what a high percentage of the tumors in the stomach appear to be actually benign I think that in spite of the fact that they appear to be benign microscopically as well as from the typical roentgen characteristics which Dr Carter so well described, we have to be very careful about the prognosis in those cases

We have seen, ourselves, a number of them become malignant almost under our very eyes, by observation over a period of years, and, on the other hand, I have now



Fig 1 Neurofibroma of stomach wall showing normal folds of mucous membrane over filling defect

three cases, one of which I have followed for eight years, another one for four years, in which multiple tumors of this type have remained absolutely constant and have not changed their appearance whatsoever

I think the technic which Dr Carter emphasized in the beginning of his paper is extremely important if we are to make the diagnosis of these small benign polypi, and I think the diagnosis is very important because certainly a large percentage of the



Fig 2 Neurosarcoma of stomach Roentgenogram made Jan 16 1933 simulates early carcinoma Increase in size of lesion shown on second examination Sept 11 1933

malignancies of the stomach arise from such benign tumors and the diagnosis of benign polyp of the stomach may be the earliest possible diagnosis that we can make of a carcinoma

I also want to bring out just one more point and that is with regard to the intramural tumors which Dr Carter mentioned, particularly the neurofibroma. I would like to show just two slides, if I may bring that out

The diagnosis of an intramural tumor may be beautifully demonstrated if we can show the defect and then the rugal pattern lying over the defect. This was a neurofibroma of the gastric wall, and we removed it at autopsy and it demonstrated beautifully why this appearance (Fig 1) was present—the lesion extending outward to a large extent and simply displacing the mucosa over it without invading it and permitting the mucosal pattern to retain its normal appearance. Schatzki has called my attention to the fact that the demonstration of normal rugæ over a tumor defect does not always mean that the tumor is intramural because the mucosal pattern from the opposite wall may be producing the roentgen findings

Some of these cases are malignant, as shown in Figure 2. We saw this patient at this time, knowing nothing else about the history. We found a small area of infiltration on the lesser curvature and I was very proud of the diagnosis of early carcinoma of the stomach. It was later discovered that the patient had some tumors in the lung, which certainly did not look like the ordinary metastasis, but in view of the diagnosis of carcinoma were considered to be metastasis—no surgery was attempted

I saw the patient some seven months later and you see the change in the appearance with the invasion of a tumor extending into the stomach and which is beginning to take on the characteristics of a typical malignant lesion

This proved to be a neurofibrosarcoma, such as Dr Carter mentioned, and these lesions in the lungs were neurofibromas which had undergone malignant degeneration and had become neurofibrosarcoma. This is not as uncommon a tumor as you might think. Neurofibromatosis is not unusual and the tendency is to involve the stomach in a considerable number of cases

HERNIA OF THE CARDIAC END OF THE STOMACH THROUGH THE DIAPHRAGM¹

By MAURICE F DWYER, M D , F A C P , *Seattle, Wash*

DURING the past decade many articles have been written on diaphragmatic hernias involving the cardiac end of the stomach, and in reviewing them one is impressed with the variations in the incidence of such hernias and in the clinical importance attributed to the various forms.

The term "diaphragmatic hernia" suggests to the majority of physicians a tear in the diaphragm, or a protrusion of a portion of a viscus through an opening in the diaphragm as the result of trauma. It may more accurately be defined, however, as a protrusion of abdominal contents through an abnormal opening in the diaphragm which has resulted from imperfect development, anatomic weakness, or trauma. Recent statistics show that diaphragmatic hernia due to trauma is uncommon, comprising less than one-third of the reported cases. These hernias are classified as approximately one-third congenital, a little more than one-third acquired after birth, and less than one-third traumatic.

The majority of diaphragmatic hernias follow no known injury, and consequently the relaxed or enlarged openings in the diaphragm, capable of permitting the protrusion of a viscus at some time during life, must be assumed to be congenital in origin. Imperfections of development, such as harelip, cleft palate, spina bifida, hypospadias, and relaxation of the inguinal rings, are well recognized. It is, therefore, not at all strange that a structure as complicated as the diaphragm fails at times to develop normally. Thus if prenatal fusion is at all imperfect the strains to which this imperfectly developed structure is subjected in early life—such as birth trauma, crying, violent coughing, spasms, etc., all of which increase intra-abdominal pressure—may result in hemorrhagic infiltration in

the diaphragm. The consequent fibrosis and stretching following the hemorrhagic infiltration may, in turn, result in herniation through a weakened area. While this condition may not be truly congenital, still it does occur in very early childhood.

The true incidence of diaphragmatic hernia is hard to determine, as there is such discrepancy in the literature, however, it is certain that at present many more cases are diagnosed than formerly, and occasionally a previously unexplained abdominal complaint on re-examination is accounted for by a protrusion of a portion of a viscus through an opening in the diaphragm. As this paper is to deal solely with hernia of the cardiac end of the stomach, other types of diaphragmatic hernia and abnormalities of the diaphragm will not be discussed.

Harrington (1), in discussing the incidence of diaphragmatic hernia as found in the Mayo Clinic over a period of 32 years, brought out the interesting point that during the latter eight years five times as many cases were diagnosed at the Clinic as in the preceding 24 years. In 1931, Hedblom (2) reviewed the literature and tabulated 1,435 cases. Of these, 190 (13.2 per cent) were hernias through the esophageal hiatus. Ritvo (3) found 60 cases of hernia through the esophageal orifice in 9,000 routine examinations, an incidence of 0.7 per cent of patients complaining of general gastric symptoms.

In comparing reports published during the past ten years with those published previously, there can be no doubt but that the incidence of diaphragmatic hernia, especially that through the esophageal hiatus, is increasing rapidly. This increase is due to the fact that the clinician is becoming more familiar with the symptoms suggestive of a diaphragmatic hernia, and is thereby directing his attention to the diaphragm, especially in the absence of objective findings.

¹ Presented before the Radiological Society of North America at the Twenty-second Annual Meeting, at Cincinnati, Nov. 30-Dec. 4, 1936.

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at an embryologic fusion point. A hernia not due to trauma may, theoretically at least, occur at any of the normal openings eventually force some one or other of the abdominal organs into the thorax. The size of the opening varies considerably

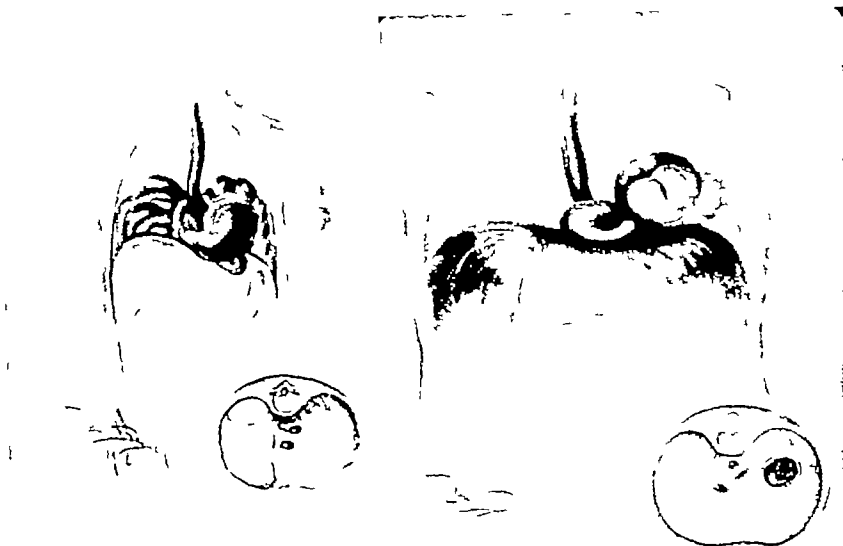


Fig 2 Hernia through the pleuro-peritoneal hiatus

Fig 3 Hernia through the dome of the diaphragm

in the diaphragm, but actually most hernias of this group present themselves through an enlarged or relaxed esophageal opening. Herniations through the vena cava and aortic openings are unknown, and Healy (5) points out that this is true because the esophageal opening is the only muscular one in the diaphragm, the others being made up of tendinous attachments.

Hernia through the Pleuroperitoneal Hiatus, also called hernia through the costo-vertebral angle, is due to a failure of closure of the median and dorsal portion of the pleuroperitoneal membrane (Fig 2). The passage remains open until the third month of intra-uterine life, and that on the left possibly closes later than that on the right.

The channel of communication between the pleural space and the peritoneal cavity is the pleuroperitoneal canal. If this canal should remain open through deficiency in the rate of growth and closure, then the pleural and peritoneal cavities will not be separated completely from one another and the positive intra-abdominal pressure will

The pleuroperitoneal passage is small at the time the hernia occurs, being approximately the same size in relation to the rest of the abdominal wall as the orifice of a large inguinal hernia is in the adult. Complete absence of the left half of the diaphragm is an exaggerated form of this type of hernia.

Hernia through the Dome—This hernia is an opening actually through the substance of the diaphragm and is independent of any of the natural openings (Fig 3). It is due to rupture or destruction of a portion of the membranous diaphragm. The defect is more common in the left dome than in the right, which is accounted for by the protection given the diaphragm by the large right lobe of the liver. The position of the defect is fairly constant, though there may be considerable variation in its extent, and the aperture may be round or oval. A portion of the stomach and colon is invariably herniated and occasionally the spleen and portions of the small intestine may be found in the thorax.

The presence of this abnormal opening is

to account for the symptoms, and also to the fact that roentgenologists now are constantly keeping such a lesion in mind and

demonstrated such a lesion, the clinician and roentgenologist must not then rest on their oars and consider that, having found

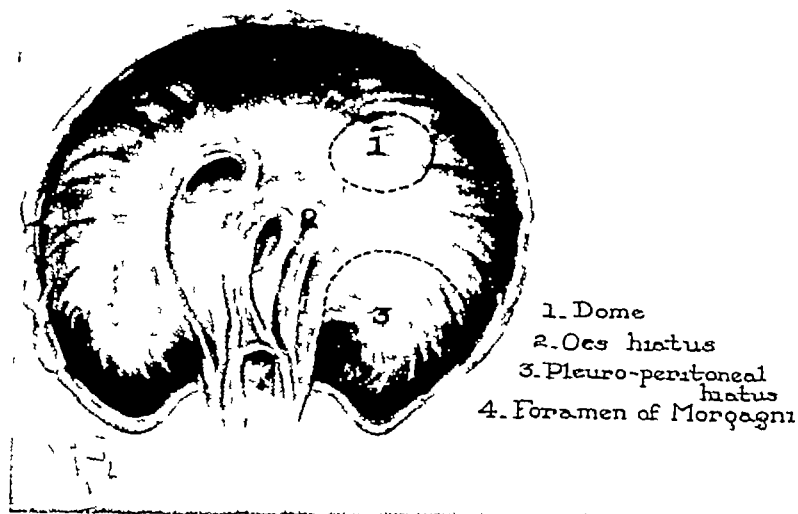


Fig 1 Sites of diaphragmatic hernias

are employing a technic of fluoroscopic examination necessary to demonstrate the hernia. If the roentgenologist does not himself elicit suggestive clinical signs and symptoms of the probable existence of a gastric hernia, the possibility of such a condition must be mentioned to him by the clinician, for esophageal hiatus hernias will nearly always, unless of large size, be overlooked if the patient is examined only in the vertical position.

We have a record of seven cases in a series of 6,500 routine gastro-intestinal examinations. It is obvious that in the past some cases have been overlooked because not sufficient clinical and roentgenologic importance was attributed to herniation of the cardiac end of the stomach as an entity causing gastric symptoms. On the other hand, the writer does not wish to convey the impression that these hernias are a relatively frequent source of gastric complaints, and that every protrusion of the cardiac end of the stomach through a diaphragmatic opening, no matter how small, is the cause of the symptoms for which the patient has sought relief. After having

the hernia, they have made a complete diagnosis. To do so without further investigation may result in overlooking a diseased gall bladder, a gastric ulcer, or an esophageal lesion. However, a hernia of the cardiac end of the stomach, especially through the esophageal hiatus, may be the sole cause of the gastric symptoms and must be constantly borne in mind by both clinician and roentgenologist and recognized when present.

A simple and practical classification of diaphragmatic hernia is as follows: (1) congenital, either true or false, (2) acquired, either true or false, and (3) traumatic (Fig 1). Harrington (4) states that the congenital and acquired types occur through (1) the dome of the diaphragm, (2) the esophageal hiatus, (3) the pleuroperitoneal hiatus, or foramen of Bochdalek, (4) the foramen of Morgagni, and (5) any embryonic fusion point of the diaphragm.

The traumatic type may be classified as (1) those due to direct injury, such as gunshot or stab wounds, which may occur at any point in the diaphragm, and (2) those due to indirect injury, which usually occur

Esophageal hiatus hernias are essentially congenital in the same sense that hernias in the inguinal region are congenital. Due to a deficiency in embryological development there may be a congenital weakness of the esophageal ring, and, as in inguinal hernia, later on in life, through trauma, pregnancy, or any increase in intra-abdominal pressure, a definite hernia may develop. Many persons with abnormally relaxed esophageal hiati go through life without the slightest herniation of a viscus through the relaxed opening, and only after the increase of intra-abdominal pressure from some cause forces enough of the stomach or intestines through the opening to produce symptoms, is the condition suspected.

Harrington, in order to determine the variation of size of the esophageal ring, examined this opening in 500 cases during the course of other abdominal operations. The summary of his findings showed that in 65 per cent of cases the diaphragm was closed tightly around the esophagus, and he could determine no appreciable space between the two structures. In 35 per cent of cases one finger or more than one could be placed between the esophagus and the margin of the diaphragmatic opening. Of this group, in 55 per cent only one finger could be inserted between the esophagus and the diaphragm, in 40 per cent two fingers could be inserted, and in 5 per cent three fingers could be so inserted. In all the cases in which three fingers could be inserted, special roentgenologic examinations were made later and occasionally revealed a small hernia.

Hernia through the esophageal hiatus is the most frequent variety of diaphragmatic hernia found in adults and may exist for years without producing symptoms. These hernias as a rule present more uniform symptoms than hernias situated elsewhere in the diaphragm because usually the only organ involved is the stomach. The symptoms, therefore, are chiefly suggestive of a stomach lesion or a reflex condition producing gastric symptoms, and the severity of the symptoms generally depends upon the degree of herniation of the stomach.

There is no characteristic set of symptoms or syndrome diagnostic of this condition, and a pre-operative diagnosis can be made only by the roentgenologist. Hernias through the esophageal hiatus, however, do present symptoms some of which should make the clinician strongly suspicious of this condition. On the other hand, many symptoms, indefinite in themselves, merge into the general group of stomach complaints so commonly associated with various lesions of the upper abdomen. In reviewing the histories of such cases, the clinician must constantly bear in mind that a diaphragmatic hernia may be the cause of the complaint for which the patient seeks relief.

Harrington (8), emphasizing this, stated that the diaphragm should always be examined by the surgeon in all cases in which the conditions found at operation do not seem sufficient to account for the patient's symptoms, for experience has shown that some of the unsatisfactory results following operative procedures, especially on the stomach, gall bladder, and appendix, may be due to an unrecognized esophageal hernia. In recent years surgeons and roentgenologists have paid considerable attention to herniations of the stomach through the esophageal opening of the diaphragm, but on reviewing the literature on this subject we found that little has been contributed by internists, certainly nothing in proportion to what has been written concerning other conditions, the incidence and clinical importance of which are no greater.

The general symptomatology of the majority of patients presenting a herniation of a portion of the stomach through an esophageal opening in the diaphragm is usually mild at the beginning. Epigastric distress of varying degree occurs during or shortly after a meal. The severity of this distress is in proportion to the degree of herniation of the stomach and to the amount of food taken. Pain in the epigastrium is a frequent complaint, the pain varying in character from a localized dull aching distress in the lower mediastinum

difficult to explain. Hume (6) believes there are two possible explanations of the defect. The first is that there may be a de-

- 1 Esophageal hiatus hernia with congenital shortening of the esophagus.
- 2 Esophageal hiatus hernias without

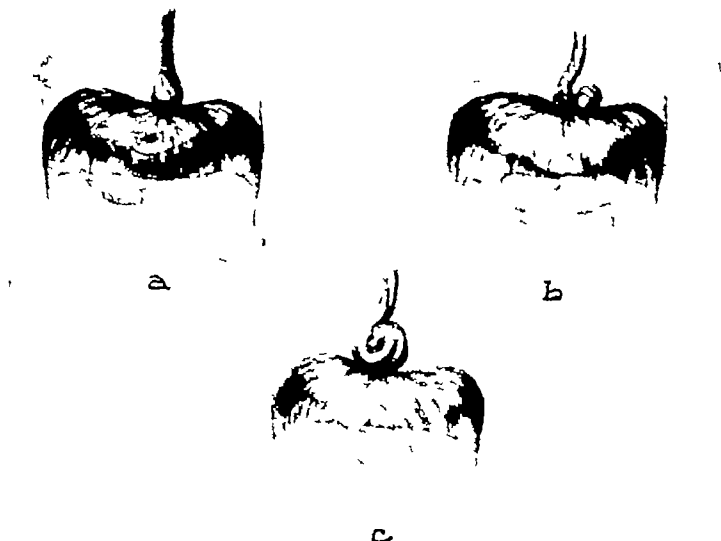


Fig 4 Hernias through the esophageal hiatus (a) Esophageal hiatus hernia with congenital shortening of the esophagus (b) Esophageal hiatus hernia without congenital shortening of the esophagus, in which the esophagus does not form part of the hernia (para-esophageal hernia) (c) Esophageal hiatus hernia in which the esophagus is not shortened but in which the distal portion of the esophagus is a part of the hernial contents

lay or interference with the growth of the pleuroperitoneal folds, causing a failure to unite with the dorsal portion of the septum transversum, and that it is possible, therefore, that some temporary disturbance of nutrition may affect the relative rate of growth of the components of the diaphragmatic premordium. The second possibility is that the herniation may occur after the membranous diaphragm has formed at the time the pleural cavity is relatively unfilled, and a portion of the membranous diaphragm lies unprotected owing to the inequality of the size of the lobes of the liver at this stage of development.

Herniation of a Portion of the Stomach through the Esophageal Hiatus is by far the most common type of diaphragmatic hernia (Fig 4). Akerlund (7) has demonstrated that esophageal hiatus hernias are six or seven times as frequent as all other non-traumatic diaphragmatic hernias combined, and has classified these hernias on an anatomical basis into three groups:

congenital shortening of the esophagus, in which the esophagus does not form part of the hernia (*i.e.*, para-esophageal hernias).

- 3 Esophageal hiatus hernias in which the esophagus is not shortened but in which the distal portion of the esophagus is a part of the hernial contents.

Esophageal hiatus hernias of the last group are the most common, and those of the first group the least common in occurrence.

The size of the esophageal hiatus may vary considerably. Embryologically this defect is due to the fact that the development of that portion of the diaphragm derived from the dorsal mesentery and the mesoderm of the receding Wolffian body leaves not only a defect of varying extent in the muscular and tendinous structures but often leaves also a deformity in the conformation of the dome of the diaphragm and a shortening of the esophagus.

probable cause for the complaint, although the history presented symptoms frequently complained of by patients with these her-

ated on and a large uterine fibroid was removed. About five years before the gastro-intestinal examination she began to

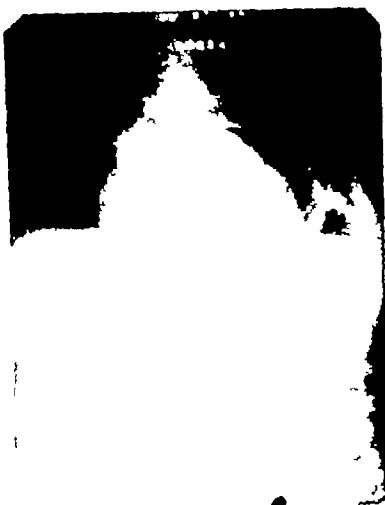


Fig 6

Fig 6 Roentgenogram of Case 2 showing over half of the stomach herniated through the esophageal hiatus



Fig 7

Fig 7 Drawing illustrating the degree of herniation of the stomach as shown in Figure 6

nias, neither was there any roentgenologic evidence of the hernia seen during the vertical fluoroscopic examination, notwithstanding the fact that a cardiospasm was suspected and special attention was paid to the lower end of the esophagus and cardiac end of the stomach. Only after viewing the roentgenograms taken in the supine position was the hernia recognized. It was fortunate that the hernia was visualized on the roentgenogram, for as a rule it is necessary to examine the patient in various oblique horizontal positions before such a hernia can be detected. Too much emphasis cannot be placed on the fact that the clinician must bear in mind the possibility of such a condition and the roentgenologist must be familiar with the clinical facts and use a technique necessary to demonstrate the hernia.

Case 2 The second patient was a 55-year-old woman whom the writer had known personally for many years. Her past history was essentially negative except that ten years before the roentgenologic examination of her stomach, she was oper-

ated on and a large uterine fibroid was removed. About five years before the gastro-intestinal examination she began to have vomiting spells associated with a moderate amount of pain occurring within a quarter of an hour to one hour after eating, and the degree of distress was in proportion to the amount of food taken. Considerable palpitation and moderate dyspnea were also frequent complaints. The severity of the symptoms increased from year to year, until finally she was unable to sit through a moderate sized meal without leaving the table, walking about, and emptying her stomach by forcing herself to vomit. Roentgenologic examination (Fig 6) demonstrated a large hernia of the stomach through the esophageal opening. Approximately half the stomach (Fig 7) was herniated through the esophageal hiatus.

About a year ago this woman was suddenly stricken with severe pain in her chest which radiated down the arm, accompanied by palpitation and considerable dyspnea. A physician not aware of the presence of this large gastric hernia diagnosed the case as coronary thrombosis. The dyspnea, substernal distress, and pain radiating

and epigastrium to an excruciating pain referred to the back and mammary regions and radiating down the arms, accompanied

than the hernia to account for the anemia. Their findings seem to warrant the conclusion that the congestion of the gastric



Fig 5 Drawing and roentgenogram of Case 1 showing esophageal hiatus hernia of the para-esophageal type

by tachycardia and increasing when the patient assumes a horizontal position. The clinical picture of a severe attack may closely simulate that of coronary thrombosis.

Pain due to the condition is often relieved by walking, bending, and the eructation of gas. Nausea and vomiting are commonly noted and occur from a few minutes to an hour after eating, depending on the degree of herniation.

Dysphagia is another relatively common complaint. The difficulty in swallowing may be temporary and mild, or it may be prolonged and so severe that an erroneous diagnosis of cardiospasm or other lesions of the lower end of the esophagus may be made.

Herniation through the esophageal hiatus may also be the cause of a previously unexplained secondary anemia. Bock (9) and his associates reported a series of 10 cases of secondary anemia due to intermittent bleeding from the portion of the stomach involved in the hernia. Clinical, operative, and postmortem examinations failed to demonstrate any lesion other

mucous membrane due to the constriction caused an increase in venous pressure, which resulted in bleeding.

A summary of the histories of two cases, showing marked difference in the degree of herniation through the esophageal hiatus, follows.

Case 1 (Fig 5), a woman 55 years old, whose history previous to six months before consulting us contained no complaints suggestive of an upper abdominal lesion. At that time she began to regurgitate the last mouthful of food swallowed. At the onset, the regurgitation was intermittent, but for the last few weeks before consulting us the regurgitation followed nearly every meal and occurred at intervals varying from a few minutes to three or four hours after eating. The regurgitated food was described by the patient as "undigested and not mixed with stomach contents." Occasionally she was awakened during the night on account of nausea, which was relieved after expelling about a cupful of fluid.

Diaphragmatic hernia through the esophageal hiatus was not considered as a

unless comparatively large, may exist for years without causing symptoms, and when demonstrated, other upper abdominal and mediastinal conditions capable of producing similar symptoms must be excluded before the hernia can be considered as the cause of the complaint for which the patient has sought relief

4 Unless the roentgenologist has some reason to suspect the presence of a diaphragmatic hernia and examines the patient in a supine position, nearly all such hernias will remain undiagnosed

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DISCUSSION

DR ERIC J RYAN (New York City)
Dr Dwyer is to be complimented on the thorough manner in which he has treated this subject. Herniation of the diaphragm is handled in a very sketchy manner in most of the standard text-books, and I think that this presentation, with its excellent resumé of the etiology, symptomatology, and diagnosis of this lesion goes far toward filling up the gaps in our knowledge.

Going back over the last 6,000 gastrointestinal examinations at St. Luke's Hospital, in New York, 19 cases of diaphragmatic hernia were reported—an incidence of 0.3 per cent.

As evidence that we are recording more of these cases in recent years than formerly, our incidence for 1932 was 0.17 per cent and for 1936, 0.44 per cent. This, I believe, is due to more careful study in at least two planes and to the fact that we have been stimulated to look more carefully for its presence.

Mention has been made of secondary anemia following bleeding due to congestion at the point of constriction. In our series of cases we have had two patients in whom ulceration occurred at this point and one case in which a massive gastric hemorrhage was the only symptom. This case was interesting from the point of view that the woman was "up in years." She was admitted with a diagnosis of gastric carcinoma—a large palpable mass. When she was x-rayed it was shown that most of the stomach, outside of the duodenum, was below the diaphragm, the large, palpable, nodular mass was a left scoliosis of the lumbar vertebræ with an advanced arthritis.

In only four of our cases were there symptoms that would suggest this lesion. All patients complained of being afraid to eat because of a sense of fullness and pressure in the chest. In addition, two of them—referred with a clinical diagnosis of carcinoma of the esophagus—gave a history of regurgitation if they partook of more than a certain amount of food. All complained of being afraid to eat.

All of our cases were herniations through the esophageal hiatus.

Careful examination in both the prone and erect positions, with the possibility of the presence of this lesion constantly in mind, will help us to recognize its presence in the majority of cases.

DR R. R. NEWELL (San Francisco)
There may be some hereditary factor in the tendency to develop hiatal hernias in advancing age. There is a Jewish family of eleven brothers and sisters of whom I have had opportunity to examine eight. All of those present hiatal hernias from 1 to 4 cm in size. None produced symptoms.

These hernias are just one of the reasons

down the arm lasted for five or six days, when the patient died. In the absence of electrocardiographic evidence and autopsy

through the foramen of Morgagni produces symptoms which are very confusing, suggesting decreased lung aeration, dullness at

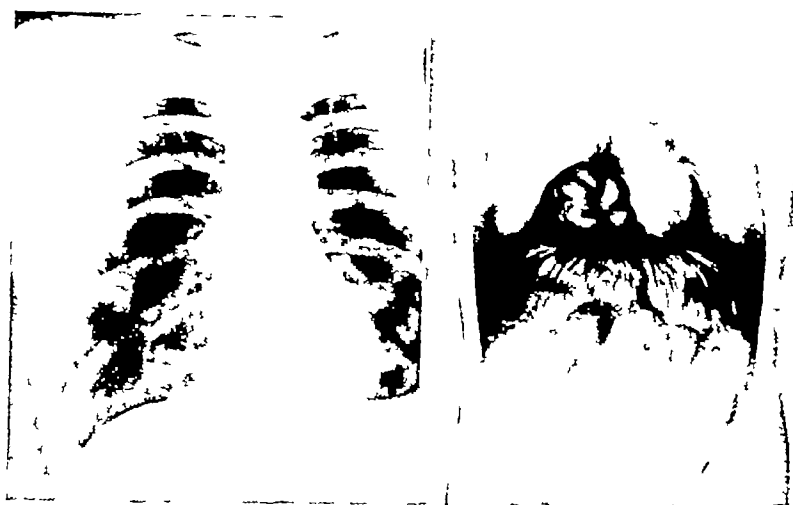


Fig 8

Fig 8 Roentgenogram showing a right-sided hernia of the transverse colon through the foramen of Morgagni



Fig 9

Fig 9 Drawing illustrating the findings as exhibited in Figure 8

findings, the question arises as to whether this large hernia might not have been the cause of death. Substernal pain radiating down the arm, dyspnea, and cyanosis have been described by various writers as caused by such a hernia, and on account of the size of this hernia relatively severe symptoms would be expected.

Diaphragmatic hernias through the pleuroperitoneal hiatus or foramen of Bochdalek and the dome of the diaphragm on account of the variation in size and location frequently involve other viscera than the stomach. The small and large bowel, spleen, and left lobe of the liver have been found herniated through these openings. The symptoms, therefore, are very indefinite, and the pathologic condition without roentgenologic findings would not be diagnosed clinically. The symptoms vary considerably with the viscera involved, and often because of symptoms suggesting cardiac and respiratory lesions the entire attention of the clinician is directed to the thorax. Herniation through the right side of the diaphragm other than

the base, pleurisy, cyst of the liver, and bronchiectasis.

Many deaths in children attributed to thymus, congenital heart, atelectasis, and pneumonia are caused by a large diaphragmatic hernia.

Hernia through the foramen of Morgagni (Figs 8 and 9) always involves the colon, and the clinical picture is that of partial or complete obstruction of the large bowel.

SUMMARY

- 1 The incidence of herniation of a portion of the cardiac end of the stomach through the esophageal hiatus is on the increase.
- 2 Herniation of a part or all of the cardiac end of the stomach is a definite clinical entity. The hernia produces suggestive symptoms and must be constantly borne in mind, both by the clinician and by the roentgenologist, as a possible cause of gastric complaints.
- 3 A hernia of the cardiac end of the stomach through the esophageal hiatus,

why we should always examine our gastro-intestinal patients supine and prone as well as standing

DR FRANCIS V MARTIN (Michigan City, Ind) I did not hear the first part of the paper, but, living as I do in a section where automobile accidents are perhaps more common than in most sections, I have seen two cases of ruptured diaphragm and in both of these I was able to foretell the condition by the clinical symptoms—by what I was able to hear and feel in the chest—by listening and palpation

One could hear the bowel sounds away up in the chest where they should not be, and that, to me, in both those cases, allowed me to foretell the fact that we had a ruptured diaphragm with which to deal

In one case the stomach, the spleen, the colon, and a large part of the small bowel were in the left chest, filling the whole chest cavity The man died within a few hours The other case was one in which a man was caught between two box cars He was ill for months, and there was a lawsuit over the case The judge appointed me to examine him I found the greater part of the stomach in the chest cavity

In both cases I was able to detect the probable condition by physical examination

DR ERNST A MAY (East Orange, N J) In every gastro-intestinal examination we should look for a possible diaphragmatic hernia Of the three methods which aid us in locating the presence of a diaphragmatic hernia, the Trendelenburg position is the most important one Through the force of gravity alone the organs of the abdominal cavity, such as stomach, intestines, or omentum, may enter the chest through the defect in the diaphragm

The second aid is the Mueller test It consists of a forced inspiration which is sud-

denly stopped by allowing the patient to close the glottis while he is still trying to inhale The diaphragm will descend to an extreme position and the hernia, through this low position as well as the increased negative pressure in the chest, will be larger

The third is the Valsalva test This method is not as useful as the Mueller test, but will aid in the differential diagnosis After deep inspiration the patient closes the glottis and tries to make a forced expiration In the abdominal type of breathing of the male, the increased abdominal pressure will force a part of the abdominal contents into the sac of the hernia above the diaphragm The hernia, however, may disappear entirely, if, in the thoracic type of breathing of the female, the pressure in the thorax plus that of the diaphragm is greater than that of the abdomen

As I have demonstrated in the case of bilateral diaphragmatic hernia which I reported in RADIOLOGY, April, 1933, fixation of the hernia in the chest by adhesions will change the results of these tests according to the amount of adhesions present

DR MAURICE F DWYER (closing) I sincerely thank Dr Ryan and the other gentlemen for their excellent discussion of this paper

Throughout this paper I have tried to emphasize that hiatus hernias are not common, and when found, the physician must not consider these hernias as the cause of the symptoms for which the patient has sought relief until by careful examination he has excluded other conditions of the upper abdomen capable of producing symptoms closely simulating those of hiatus hernias These hernias, however, are a definite clinical entity Such a hernia may be the cause of the patient's complaint and should be thought of and recognized when present

PRIMARY MALIGNANCY OF THE SMALL INTESTINE¹

By EDWARD W. ROWE, M.D., and J. MARSHALL NEELY, M.D., *Lincoln, Nebraska*

INTRODUCTION

SINCE Lubarsch (15) described a malignant tumor of the small intestine in 1880, primary malignancy of the small bowel has been considered a rare occurrence, its diagnosis before operation unusual, and its roentgen interpretation so difficult that it was well nigh impossible. However, the increasing interest in the study, together with the stimulation of the advancements made in roentgenology, has revealed its more frequent occurrence, the possibility of pre-operative diagnosis and the lessening of the mortality rate. Thus have many dark fields in diagnosis yielded to routine accuracy in method and in determination of the correct interpretation of roentgen findings. It is not enough to wait for obstruction of the bowel or for the fatal signs of malignant disease. Medical service writes a proud chapter when a malignant tumor of the bowel is determined while there is yet time for palliation or for cure. Greater accuracy in diagnosis will result when there is better knowledge of neoplasms of the small bowel, of the clinical history, and especially of the normal and pathologic roentgen aspects. It is self-evident that greater care must be taken in the routine examination and special adaptation of the barium meal to the functions of the small bowel in health and disease.

STATISTICAL DATA

One of the most complete studies of tumors of the small intestine was published by Dr. F. S. Raiford (25), from the Surgical Department of Johns Hopkins Hospital, in 1932, who found 88 cases of tumors of the small intestine in a review of the records of 11,500 autopsies and 45,000 surgical specimens.

¹ Presented before the Radiological Society of North America at the Twenty-second Annual Meeting, at Cincinnati, Nov. 30-Dec. 4, 1936.

VARIATIONS AND LOCATIONS OF TUMORS OF THE SMALL INTESTINE (25)

Type	Duo- denum	Jeju- num	Ileum	Unde- ter- mined	Total
Carcinoma	7	4	3	2	16
Sarcoma	0	1	1	0	2
Lymphoblastoma	1	0	18	2	21
Adenoma	4	1	10	0	15
Myoma	0	1	2	0	3
Fibroma	1	0	3	0	4
Hemangioma	1	1	1	0	3
Chylangioma	0	1	0	0	1
Hematoma	0	0	1	1	2
Accessory Pancreatic Tissue	2	3	1	0	6
Argentaffin Tumor	1	1	5	0	7
Lipoma	3	1	3	0	7
Cyst	1	0	0	0	1
Total	21	14	48	5	88

In his review of the literature, Raiford (25) found 339 tumors of the small intestine. His own cases were distributed as follows:

All Tumors	Gastro-intestinal	986
	Small intestine	88 (8.9%)
Benign Tumors	Gastro-intestinal	210
	Small intestine	50 (23.8%)
Malignant Tumors	Gastro-intestinal	776
	Small intestine	38 (4.9%)

In order of frequency, the terminal ileum leads in both benign and malignant tumors. The duodenum is next in susceptibility, and the jejunum is relatively free. Malignant tumors are usually large and single, involve the glands, and spread to the mesentery. Benign growths are smaller, often multiple, and usually polypoid.

Brill (1) reports 3,563 cases of malignant tumor of the intestine, 89, or 2.5 per cent, in the small intestine.

Doub (7), in 1936, reported 15 cases of primary malignancy of the small intestine, as follows:

(1) Carcinoma of duodenum	9
(2) Carcinoma of jejunum	3
(3) Sarcoma of duodenum	1
(4) Carcinoid carcinoma (a) jejunum	1
(b) cecum	1

Mateer and Hartman (17), in 1932, reported

176,000 admissions to clinic (Detroit)
6 cases primary malignancy of intestine proven by autopsy

The term "lymphoblastoma" as used here includes such pathologic entities as Hodgkin's disease, lymphosarcoma, and leukemia. Tumors of this type being prevalent in the fourth and fifth decades, may be expected at a slightly earlier age, and are more common in males than in females. In contrast to carcinoma, the small intestine is more commonly involved than the colon or stomach. The mesenteric lymph nodes are almost always involved though this involvement is simultaneous and not metastatic. In Rairford's (25) cases, lymphoblastoma is more common than carcinoma and is found most often in the ileum. Multiple tumors are frequently seen in Hodgkin's disease of the small intestine, though the single tumor is the rule in lymphosarcoma. Secondary inflammatory change often makes accurate histologic classification impossible in this group of tumors, and perforation of the intestinal wall, with resulting peritonitis, is not infrequent.

Two of the eight cases making up this group are lymphoblastomas. One of these (Case 7) is a typical abdominal Hodgkin's disease histologically and has been previously reported elsewhere (19). Multiple large polypoid tumors occurred in the jejunum and ileum and there was also multiple perforation of the bowel wall, with general peritonitis. Secondary inflammatory reaction made histologic classification difficult, but tissue remote from the areas of perforation revealed changes characteristic of Hodgkin's disease. The other lymphoblastoma was found in the terminal ileum and is probably a lymphosarcoma, although, as is indicated in the case report, there is a difference of opinion among various pathologists who have examined the material, one believing it to be Hodgkin's disease and another, lymphosarcoma.

CLINICAL HISTORY

As a rule, symptoms of malignant tumors of the small intestine are vague before the onset of complete obstruction. Pain, vom-

iting, increasing constipation, and rapid emaciation commonly occur. Doub has described a clinical picture for many types and locations, and such a detailed effort is commendable. In general, symptoms may be divided into those before and those after obstruction begins. All diagnosticians are fully informed of the signs of ileus and intussusception, but greater care in study of symptoms before either of these calamities occur is necessary, if a timely diagnosis is to be made.

Early appearance of visible peristalsis in any part of the abdomen and occult blood in the stool should make one think of tumor of the small intestine. In some cases, obstruction is so late that anemia, loss of weight and cachexia are present to a greater or lesser degree. There is a group of symptoms arising in the greater number of cases, in which the complaints point to the region involved and constitutional changes indicate profound illness. A lesser group occurs in which the outstanding symptoms are constitutional and the regional manifestations are obscure. Gradual occlusion by the growth gives rather characteristic symptoms of belching, bloating, and a feeling of heaviness in the abdomen. The patient is below par, fatigues easily, his weight decreases, and the symptoms of obstruction precipitate, to remit again or to remain for the final stage of total occlusion. Slight colicky pain in the abdomen, waves of peristalsis, nausea, and later, vomiting should, with a palpable tumor, localize the region involved. Bowel movements may be normal at first and then become infrequent, or the stool may become scanty and tenesmus be troublesome. As a rule, the higher the tumor the more violent the symptoms and the earlier vomiting occurs.

The clinical findings are usually divided into (1) those of the duodenum, and (2) those of the jejunum and ileum. The latter are sufficiently alike to be described together. The malignant tumors of the jejunum and ileum have fewer localizing symptoms and signs. The length of the prodromal signs varies greatly. Some-

Forgue and Chavin (10), in 1915, reported

88,031 autopsies, and cancer in 6,847 (8%)

642 cases (9%) intestine

603 (94%) large bowel

39 (6%) small bowel

Craig (5), in 1923, reported

4,584 carcinomas of gastro-intestinal tract and
36 of these were in the small intestine

Netttrou (20), of the Mayo Clinic, 1936, stated in the Clinic's bulletin that carcinoma of the large bowel is eighty times as frequent as cancer of the small intestine. He found carcinoma of the small intestine most frequently in the jejunum.

PATHOLOGY

Primary neoplasms arising in the small intestine may be benign or malignant. Benign tumors will be considered only briefly because this communication has to do with malignant neoplasms. Rankin and Newell (28) describe 35 cases of benign tumor of the small intestine, listing adenoma, myoma, fibroma, and lipoma. They state that benign tumors occur about half as frequently as carcinoma. Malignant tumors of the small intestine may be of epithelial or mesenchymal origin. Masson (16) has shown that the carcinoid tumor, which may be either benign or malignant, is of neurogenic origin.

The preceding tables show some discrepancy in the relative frequency of the various types of neoplasm. In Raiford's (25) series the lymphoblastoma group is most common. The series reported by Doub (7) shows adenocarcinoma most often. Adenocarcinoma is found in the jejunum more frequently than in the ileum or duodenum, according to Rankin and Mayo (27).

There are two types of carcinoma found in the small intestine: one develops from a pre-existing polyp, and the other simulates the ring-like, constricting carcinoma commonly found in the colon. In either of these two types obstruction is the rule, and metastasis occurs early. The mesenteric lymph nodes, peritoneum, liver, lung, long

bones, and spinal dura are usually involved in the order named (27). In Craig's (5) report of 36 cases, metastasis occurred in 53 per cent. He found the prognosis worst in those cases in which the primary carcinoma was in the jejunum. Histologically, the most common type of carcinoma is the well-differentiated adenocarcinoma. Scirrhus or more undifferentiated types may be seen.

Five of the eight cases forming the basis for this paper are typical adenocarcinomas histologically, and all of them are located in the jejunum. All of these patients, including the one who is still living, show metastasis to the mesenteric lymph nodes. Distant metastasis did not occur in any case. The one remaining carcinoma is a colloid carcinoma which occurred in the first portion of the duodenum. Although the pathologist considered this as a primary carcinoma of the duodenum, at the time of autopsy, the fact that the pylorus was involved, with the histology, makes one feel that a primary carcinoma of the pylorus of the stomach is not entirely ruled out. This is particularly true when one remembers that colloid carcinoma of the stomach is not uncommon.

Carcinoid, or argentaffin tumors of the small intestine, do not occur in this small series of cases. Cooke (4), in an excellent review of cases, reports 11, three being malignant and eight benign. Intestinal obstruction was found in all those which were malignant and in one of the benign group. The tumor was found in the ileum in nine of these 11 cases. Though these tumors were formerly thought to be derived from epithelium, Masson (16) and others (4) have shown them to be neurogenic in origin. About 20 per cent of carcinoid tumors arising in the small bowel become malignant, metastasis being found most commonly in the regional lymph nodes and liver.

Sarcoma of the small intestine is rare, having occurred only twice in Raiford's series of 88 cases. The tumor may be either a fibrosarcoma or a myosarcoma; none occurred in this series.

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Morse and Cole (18), in 1926, read before this Society a most complete study of the anatomy of the normal small intestine as observed roentgenographically. They believed that a procedure of roentgenographic examination could be devised which would enable one (1) To recognize the roentgenographic appearance of the normal small intestine, together with those variations in appearance which come within so-called normal limits, (2) to study the motor phenomena of the small intestine, (3) to recognize and identify pathologic conditions involving the small intestine and functional derangements of the small intestine.

Their study of the contour, caliber, and the groupings of the small intestines is classic and worthy of the foundation for all reports upon this portion of the digestive tract. Very definitely the coils may be found in certain portions of the abdomen if observed at the proper time, exactly as they described them, and when the patterns or the positions vary, some explanation must be offered to explain the variance.

Again, in 1935, Dr. Cole and Dr. Pound (3) offered a valuable contribution to the knowledge of the small intestine, discussing, (1) the normal and (2) the interference of inflammatory lesions with the motor phenomena.

The work of Pendergrass and his co-workers (23) has been most thorough. They have called attention to the variations in the emptying time of the stomach and small intestinal patterns under a variety of conditions which may be imposed on the gastro-intestinal tract, by lesions not primarily involving the tract itself, by drugs, and by operation. He points out the groupings of the small intestines, their change in contour, and their individual patterns, how they appear normally with different types of contrast medium. He introduces a terminology—segmental contractions, feathery snow flakes, bolus, herring bone, coin shapes, piled coins, trabeculation patterns, degrees of motility, etc., and helps to give them definite meanings.

To many, the small bowel simply lies within the abdominal cavity, beginning at the pylorus and terminating at the cecum. In between lies a no-man's-land of such protean patterns that it is hardly adaptable to scientific description.

Similar illuminating studies on the action of the small intestine have been made by Etienne Piot (24), in France, and by Hans Pansdorf (22), in Germany. There seems to be agreement now on Forssell's mucosal formations and rapid changes in patterns, Ludwig's pendulum movements and peristaltic waves, Cannon's segmentation and rosary-like formations, that movements in the small bowel are more rapid in the upper tract and quieter in the distal, as in the colon, that there is no rhythmic discharge of the ileocecal valve, and that the valve seldom if ever protrudes into the cecum, that antiperistalsis has rarely if ever been seen, and that palpation promotes evacuation of intestinal loops.

It has been found that certain conditions and drugs must be understood or they complicate the picture. Hyperthyroidism causes increased motility. Myxedema causes slowness and slowed evacuation. Inanition delays evacuation. Loss of consciousness stops all movements. Atropine slows all movements. Fat delays grosser movements, and achylia increases motility.

The roentgen examination of the small intestine, properly carried out, is unfortunately a time-consuming and relatively expensive procedure. In properly selected cases, it will disclose the solution to an otherwise puzzling problem. Clinicians are recognizing more and more the value of a careful examination in obscure lesions of the gastro-intestinal tract. Positive findings depend on the stage of the disease. They are not always infallible, and because of the lateness of an opportunity to study the usual case, the findings may not be very determinate. Even positive findings may not be pathognomonic; neither do negative findings exclude the possibility of a tumor. There must be careful and intelligent correlation of the clinical find-

times four to six months may intervene before obstructive signs appear. Usually the onset is sudden.

In carcinoma of the duodenum, the first and third portions may be grouped together. (1) Pain appears—dull, dragging, not related to meals, paroxysmal, seldom referred, diffuse in epigastrium, and more intense in the region involved. (2) Nausea and vomiting are common complaints, occurring later than pain. Hematemesis is common. (3) Loss of weight and cachexia are marked as in the other gastrointestinal malignant tumors. (4) Constipation is generally the rule, but diarrhea may alternate. (5) Melena. Occult blood is usual, but black or tarry stools may be seen.

The physical findings of the first and third portions of the duodenum are (1) tenderness, which may be slight or exquisite, and which is most intense over the tumor mass. Rigidity may or may not be present. (2) Mass may be felt if large enough. It is usually resistant and fixed. (3) Ascites—if extensive—points to portal obstruction and metastasis. (4) Gastric analysis reveals low, or the absence of, HCl. (5) Blood is usually demonstrated as a gross or occult finding in the stool. (6) The blood picture shows profound anemia, in advanced stages. The white count is not elevated. (7) Pulse and temperature are not remarkable, as in anemia.

The clinical findings of the second portion of the duodenum are the same, with additional features. (1) Pain is more acute as obstruction of the pancreatic duct and biliary passage becomes marked. Back pressure and the chemical action of retained pancreatic juice cause great distress. (2) Jaundice appears early and is usually painless. It may progress rapidly without remission. Intense itching may occur. (3) The stools become clay-colored, due to the absence of bile.

The symptoms and findings of malignant tumors of the jejunum and ileum are classed together because they are similar except for the localizing value of a tumor

mass, if it can be palpated. When obstructive symptoms are present in the younger ages, intussusception is usually diagnosed, in the older, it is obstruction by slow encroachment upon the lumen of the gut, and the constitutional symptoms predominate. Recognition of the diagnostic criteria earlier than obstruction of intussusception offers the most hope. Resection of the growth and possibly roentgen therapy must be early if a life is to be saved.

ROENTGEN DIAGNOSIS

To an increasing number of the medical profession it appears that careful roentgen observations of the small intestine offer the same exactness in diagnosis as in the pylorus, the cap, or the cecum. In a review of many reports, it appears that malignant tumors of the small intestine have not been recognized often by the roentgen examination. Usually an exploratory operation has revealed the pathology.

Intestinal obstruction, intussusception, acute abdomen, and exploration of a suspected tumor mass are the common pre-operative reasons given for the operation. In most cases, the roentgen examination, if employed, has consisted of preliminary roentgenography or a routine gastrointestinal examination, not timed for the special observation of the small intestine. Recent reports indicate that there is an awakening interest in the early diagnosis of this condition.

I quote from "Roentgenographic Technique," by Rhinehart (29)

' Except the duodenum and the terminal part of the ileum, little attention is paid to the small intestine in the usual roentgenologic examination of the gastro-intestinal tract. Carman says that practically the sole abnormality of the jejunum (and upper ileum) showing roentgenologic signs is obstruction. Mills attempted to draw conclusions from abnormalities in the appearance of the small intestine which he believed were due to derangements in the tension of the gastro intestinal tract.

shoulder blade, relieved by vomiting The appetite has been fair until recently, but is becoming poor When gas is absent, she is hungry Patient is constipated

Loss of weight is questionable, color fair, abdomen soft but generally tender Liver tender and margin felt one inch below the costal arch No peristaltic waves are seen, no masses palpated, no gas distention Temperature, 99 degrees, pulse, 100, blood pressure 70/180

Blood hemoglobin, 28 per cent, red blood cells, 2,500,000, white blood cells, 5,800

Four stools were examined occult blood was found in three, no gross pus, bile or blood

Roentgen Examination—"The duodenum was full and dilated, giving one the impression of obstruction lower in the small bowel At the end of 24 hours there were traces of barium in the stomach"—(Dr R L S)

The patient refused surgery Ten months later, she died

Protocol—"Stomach dilated to three times its normal size Lining mucosa folds are widely separated Scar on greater curvature Duodenum greatly dilated Jejunum for nine inches gives the appearance of a second stomach Distal to the out-pouching there is an irregular lumen On section, the ring is found to occupy about one inch of the intestinal wall It is rather friable, but cuts with increased resistance This growth occurs in the first foot of the jejunum The remainder of the small and large intestine is essentially negative

"Cause of death Carcinoma of jejunum with metastasis in mesenteric glands and liver"

Pathologist's Report—"Tumor papillary adenocarcinoma of jejunum"

Histopathology—"A more or less normal mucosa covers the area The gut wall is markedly thickened by the tumor The muscle layers are intact but widely separated by loose papillary carcinoma That on the serosa is much more compact"

Case 2 Mrs Jennie H, examined



Fig 1 (above) and Fig 2 (below) Case 1
Papillary adenocarcinoma of jejunum

April 1, 1929, referred by Dr J S W and Dr H J L, aged 52 years, widow, housewife

ings with the objectives of the roentgen examination

The duodenum is best seen in the first half-hour after the ingestion of the meal. Its behavior in this period should indicate if a more detailed examination than usual is desirable. Study of the small intestine should begin when the stomach first begins to empty. After the examination of the stomach further observation of the small intestine should be made at half-hour intervals—at six hours for ileum, at nine hours for the ileal stasis, and again at twenty-four hours for occasional ileal stasis. Ileal stasis, or gas, in the small intestine always need explanation. A barium enema should be employed not only for colon but also for a complete ileal study. Sometimes the contrast enema is an advantage.

In the duodenum may be found obstruction, unusual motility, dilatation, destruction of pattern, filling defects, narrow, irregular passage if produced by encroachment on the lumen, or a narrow canalization. In the jejunum may be revealed the same findings plus the tumor itself. The outlines of a tumor may be seen on the preliminary films and confirmed with the barium meal. In either, the assumed patterns may indicate the pathology. The true filling defect, which is an irregular outline of a protruding growth into the lumen of the bowel, is as pathognomonic as in the stomach wall. Distal ends have appeared bulbous, revealing the outlines of growth as well as the obstruction.

CONCLUSIONS

In view of the rare occurrence of tumors of the small intestine, which have been diagnosed as such by roentgen observation or even after complete clinical study, a task has been set for the roentgenologist. Cases are usually diagnosed by the surgeon as intussusception or obstruction of the bowel, and the true pathology has been revealed either at operation or at biopsy or post-mortem. The roentgen findings of the normal small intestine vary much in

health with each individual and with different types of media used in the visualization of the contour and mucosa. Abnormal findings from drugs or from extrinsic pathology are so commonly met that their presence must be anticipated. Pains-taking technic especially adapted to the study of the small intestine must be carried out, if the true pathology is to be determined in time for relief.

An increasing number of primary malignant tumors of the small intestine have been recognized by roentgen examination before operation. Two of the cases whose history follows have been treated, one surgically and one by roentgen therapy, and are alive to-day. It is just as certain in this field as in others, where the criteria of diagnosis are well known, that findings of high accuracy will in time appear in our literature and be accepted in the routine day's work.

TABLE I

	Lancaster County Laboratory	Bryan Memorial Hospital	Lincoln General Hospital	Lincoln Clinic
No. Patients		14,418	30,032	28,260
Autopsies	1,191			
Tumors of Gastro-intestinal Tract	91			112
Malignant Tumors of Gastro-intestinal Tract	74			107
Primary Malignant Tumors of Small Intestine	8	3	5	4
Location of Tumors		Living Patients		
Duodenum	1	Resection jejunum		1
Jejunum	5	Roentgen Therapy of Ileum		1
Ileum	2			—
Total	8	Total		2

CASE REPORTS

Case 1 Mrs. E. E. L., examined Aug. 4, 1928, referred by Dr. J. S. W. and Dr. H. J. L., aged 42 years. Complaints of gas accumulation, bitter taste and nausea, which began a year before and are growing worse. Spells of vomiting large quantities of green bile or food, sometimes amounting to a quart. There are short respites between severe attacks. Pain is frequent in upper abdomen, radiating to the right

tal for a ventral hernia and a mass which was considered malignant and inoperable was found in the abdomen. The ventral hernia was closed. Because of an internal hemorrhage she had a stormy convalescence. Spinal anesthesia was used. She recovered, but complained of pain in the lower legs accompanied by anesthesia, which she attributed to the spinal block.

Examination—Below the umbilicus in the mid-line and extending into the left side was a hard, fixed mass, the size of an orange, tender on pressure. Urine examination showed a trace of albumin, microscopic pus. Blood hemoglobin, 24 per cent, red blood cells 1,800,000, white blood cells 7,800.

Diagnosis—General carcinosis of unknown origin.

Dyspnea and weakness grew worse. There was no vomiting until the last day. She died five weeks after entering the hospital. There was no record of any roentgen examination.

Protocol—"In the small intestine about three feet from the pyloric ring at what appears to be the jejunal area or near the proximal end of the ileum is a large mass two inches in diameter. Upon section of the bowel at this point, the mass is found encircling the bowel and has the appearance of circular, infiltrating, primary malignant tumor. The tumor extends into the lumen of the bowel and apparently has caused almost complete obstruction. The remainder of the small intestine shows nothing remarkable except some isolated nodular tumors. The mesenteric lymph nodes are enlarged and show metastatic growths."

Pathological Report—"Adenocarcinoma of jejunum."

Case 4 Mrs. Pauline R., examined May 24, 1932, referred by Dr. J. S. W. and Dr. O. E. L., aged 26 years. Brought to the hospital suffering from acute localized pain in the right lower quadrant. Pulse 90. Temperature 99 degrees. A palpable tumor with moderate rigidity and tenderness. There was nausea, and vomiting had occurred. The pain was severe. The

bowels had been evacuated by enema. White blood count 6,500. Diagnosis: Acute appendicitis, with reservations.



Fig 5 Case 5 Colloid carcinoma primary in the duodenum

At operation the appendix was found slightly injected, and was removed. The surgeon doubted its connection with the clinical history. The ileum was distended, and proximal to the ileocecal valve was a firm, nodular tumor involving the bowel wall and surrounding lymph nodes. This was thought by the surgeon to be malignant. The biopsy was reported by one pathologist as "lymphosarcoma", by another as "Hodgkin's". Final diagnosis: "Ileus from lymphosarcoma involving the ileum."

Progress was slow and stormy. Gas distention, loss of appetite, and pain. Twelve days later roentgen therapy was begun. Recovery followed promptly.

Patient returned one year and ten months later, with complaints of slight pain and a barely palpable tumor in the right iliac fossa. A second series was administered, with complete relief.

History—Menopause three years previously For 17 years she has been having attacks similar to the present, overwork or

nephritis Contributory carcinoma of jejunum, thyroiditis and myocarditis "

Protocol—"At the beginning of the duo-



Fig 3

Fig 4

Figs 3 and 4 Case 5 Filling defect of the duodenum Diagnosis carcinoma of the duodenum

anxiety precipitating them The present trouble began three months before examination with epigastric distress after meals and at bedtime

Present Symptoms—(1) Pain in epigastrium, not radiating Intervals of relief Relieved by food and soda Lately, some griping pain in abdomen below navel (2) Gas accumulation above navel (present for 16 years) Little belching (3) Ten-pound loss of weight in a year

Examination—Pulse 108, blood pressure, 172/90, temperature, 98° Slight resistance in the epigastrium, no tenderness Pelvis—multiple fibroids Urine specific gravity, 1.015, acid, albumin, 0, sugar, 0, microscopic examination, negative Blood hemoglobin, 70 per cent, red blood cells, 4,350,000, white blood cells, 4,800 Basal metabolism +16

Roentgen Examination—"Chronic duodenal ulcer "

Operation—April 15, 1929, the gall bladder and pylorus were explored, found scar and adhesions of duodenal ulcer Did a subtotal hysterectomy and appendectomy

Death—April 17, 1929 Cause, "Chronic

duodenum, just beyond the pylorus at the posterior aspect, there is a healed ulcer scar In the mid-portion of the jejunum there is a fibrinous band about the bowel, three-quarters of an inch in diameter It is firm and on opening the bowel it appears to form a definite annular constriction It gives an impression of an annular carcinoma The mesenteric glands are enlarged and cut with resistance "

Histopathology—"Small intestine—jejunum shows infiltration of the submucosa and muscularis coats of carcinoma cells, some taking on glandular formation Some areas of villi are being infiltrated by a carcinomatous growth Also a considerable amount of round-cell infiltration through the section Adenocarcinoma of jejunum "

Case 3 Mrs Emma McV, examined Oct 23, 1934, referred by Dr F S F, aged 46 years, menopause three months previously *Chief Complaints*—Nervousness, poor appetite, loss of weight shortness of breath, and pain in the lumbar area Six months before examination she had been operated on in the University Hospi-

red blood cells, 4,110,000, white blood cells, 8,400 Electrocardiograph suggests myocardial damage

X-ray Report—"Stomach steerhorn type hypertonic, normal rugæ and contour Six-hour stasis 1+ Small intestine cap full and complete, duodenal curve regular but dilated beyond to distal portion of jejunum, demonstrated at three hours, five hours, and 24 hours At end of dilated area there is a definite filling defect which is characteristic of carcinoma of jejunum It is palpable Filling defect seen on fluoroscopic and roentgenographic examinations—not just stenosis Almost complete obstruction "

Surgical Report—Carcinoma of jejunum White, stenosing mass in jejunum 2 feet below the ligament of Treitz Lymph node the size of walnut in mesentery Chronic obstruction of jejunum Resection of mass in jejunum and associated enlarged nodes Side-to-side anastomosis of jejunal ends "

Recovery, good condition at present time (July 10, 1936) This is the only case diagnosed positively before operation, and also the second of eight reported

Case 7 Mr C A B, aged 65 years, glass blower by occupation

Abstract of report in "Nebraska State Medical Journal," September, 1934 "When admitted to the Lincoln General Hospital the patient was complaining of severe intermittent pain in the lower abdomen, gaseous eructations, and loss of appetite Family history reveals the fact that the father died of lower abdominal tumor of unknown origin In 1896 the patient had severe pulmonary hemorrhage, and in 1905 a severe gastric upset of some kind Vague lower abdominal distress existed for three months One month before admission he had a chill lasting 45 minutes and pain in the right kidney region Three weeks later he was cystoscoped and the right ureter dilated This was followed by a chill and pain in the right lumbar region For two weeks before admission the patient noticed intermittent, rhythmic lower abdominal pain

"A barium meal series two days follow-

ing admission revealed nothing remarkable Urologist diagnosed right ureteral obstruction and explained the gastro-intestinal



Fig 7 Case 8 Carcinoma of jejunum

symptoms as reflex The right kidney was removed May 1, 1933 Examination of kidney disclosed pyonephrosis with obstruction at the uretero-pelvic junction and what appeared to be inflammatory tissue Patient left hospital in 18 days, after stormy post-operative course with intermittent lower abdominal pain

"Patient was re-admitted May 29, 1933, with severe pain in the left flank, which began suddenly on the day of admittance Temperature 100 degrees, rose to 101 degrees Report on preliminary radiographs is as follows 'Gas in splenic and hepatic flexure Also gas is seen in the small bowel, which indicates an intestinal obstruction Barium enema shows spasticity of the sigmoid region with definite dilatation of the splenic flexure and some dilatation of the transverse colon Gas remains in small bowel, as seen in the flat film There is no evidence of filling defect in the colon'

"On May 29 exploratory examination was done and generalized peritonitis found Several polypoid tumors of small intestine were encountered, one which was obstructing and through which there had been perforation It was resected Patient became worse and died May 30, 1933

The patient is now, two and a half years later, in excellent health. Blood picture normal.

"Malignant mass, right upper quadrant of abdomen, probably a newgrowth from the pylorus."



Fig 6 A 30 min

Fig 6 B 3 hr

Fig 6-C, 5 hr

Fig 6-D, 24 hr

Figs 6-A, 6-B 6-C, and 6-D
ment of tumor on fluoroscopy

Case 6 Shows filling defect of the jejunum, as well as stenosis. Ballotte-
Carcinoma of jejunum

Case 5 William A S, examined March 1, 1934, referred by Dr D C H, aged 60 years, married architect by occupation. The patient is bedfast, weak, pale, hands and feet are puffy, cyanosis, mentally clear and hopeful. Ten months previously occurred onset of "stomach trouble." Food would "go right through," though previously he had been constipated. Weakness came on gradually. Two weeks previous to examination he took to his bed. He had no pain or bleeding except from small piles. He had never been seriously ill, had had no injuries, his general health prior to his present acute condition had been fair. Abdomen soft and relaxed, palpable line and nodular, no marked tenderness, no resistance.

Examination—Blood hemoglobin, 20 per cent, red blood cells, 1,840,000, white blood cells, 10,800, erythrocytes very pale. Anisocytosis 1+, poikilocytes 1+, polychromatophilia 1+, normoblasts 0, Wassermann negative. Impression secondary anemia.

Roentgen Examination—"The cap and first portion of the duodenum are irregular in outline, firmly fixed and embedded in a mass apparently arising in the pyloric end of the stomach. The duodenum and jejunum are fixed in the mass which extends down into the right side of the abdomen. It also contacts with the wall of the hepatic flexure of the colon." Interpretation

Protocol—"The stomach is dilated, containing much fluid and gas. The mass, which is large, invades the duodenum and pushes the colon and gall bladder to the right. On opening the duodenum it is found to contain papillary areas which are typically malignant."

The pathologist on section of the tissue reported "Colloid carcinoma, primary in duodenum."

Case 6 Mrs Mary M, examined March 3, 1936, referred by Dr G H M, aged 61 years, widow, native of Germany.

History—Complaints of nausea, vomiting, and cramp-like pain in the left upper abdomen. Nine months previously she suffered some pain, with vomiting. Nine days prior to examination, pain began again and has occurred daily since. Six weeks previously, gastro-intestinal barium meal examination was made elsewhere (Dr F, Omaha) and reported "Normal gastro-intestinal tract." Lately, she has noticed a bulging of the left upper abdomen, accompanied by pain. Appendectomy and suspension of uterus in 1917. Surgical drainage of gall bladder in 1927.

Examination—Tumor in abdomen. Intestines can be seen to bulge and disappear, accompanied by pain and nausea. Fractional analysis shows marked hypochlorhydria, no blood. Cholecystographic examination shows normal gall-bladder function. Blood hemoglobin, 65 per cent,

months, going three days without a bowel movement. The appetite has been generally good until a few days previous to examination. She has had no relevant diseases.

Physical Examination revealed an old, dehydrated woman with enlarged heart and râles in the lungs. The abdomen was distended. In the upper abdomen was the outline of a "tumor," which disappeared after she vomited two quarts of bile and duodenal contents has remained empty since fluids were discontinued.

Roentgen Examination (Oct 20, 1932) — "Definite obstruction 15 or 18 in distal to the duodenal cap, probably at the terminal duodenum. This stenosis, which is practically complete, has produced considerable dilatation above it. Whether it is due to malignancy or to an old inflammatory affair, or adhesions, I can't say" (Dr R L S)

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Death occurred Oct 26, 1932, four days after operation.

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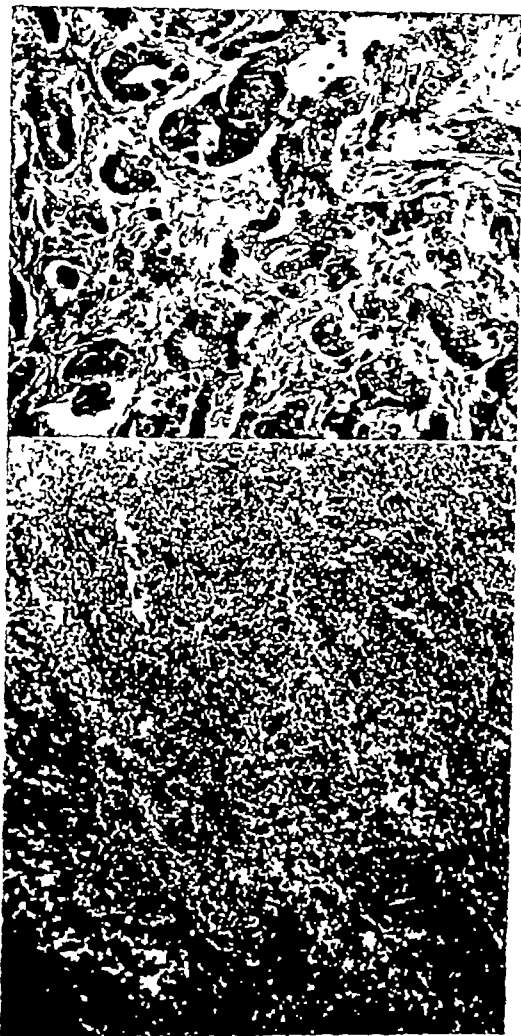


Fig 8 (above) Case 2 Photomicrograph of tissue adenocarcinoma of jejunum

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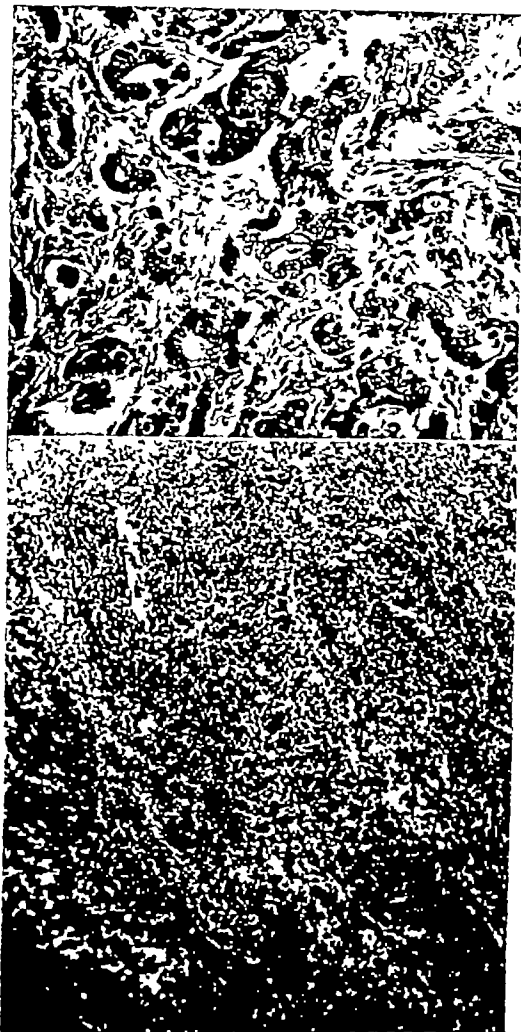


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THE MOBILITY OF THE ANTRUM, PYLORUS, DUODENUM, AND GALL BLADDER IN HEALTH AND DISEASE. THE INFLUENCE OF MOBILITY IN THE FUNCTIONING OF THESE ORGANS IN THE BILIARY TRACT¹

By NATHAN B. NEWCOMER, M.D., and ELIZABETH H. NEWCOMER, M.D., *Denver*

IN order to discuss this subject intelligently, it is necessary to give a detailed description of the method of suspension of the organs of the upper right quadrant which permits their mobility, and also, why mobility is necessary for the proper functioning of these organs. The peculiar method of their suspension also explains why these organs can assume such varied locations in the abdomen.

It is a matter of everyday observation by roentgenologists and surgeons that the location of the stomach, pylorus, cap, and gall bladder varies with different types of habitus. In the sthenic types, the organs lie high and the gall bladder some distance from the midline, in the asthenic types, the organs lie low and the gall bladder nearer the midline. The gall bladder is attached to the liver and partakes of its mobility.

Gray's "Anatomy" states

"The position of the pylorus in the erect living body of the male varies from 14.5 cm above to 8 cm below and in the female from 15 cm above to 2.5 cm below the interiliac line. The range of position in regard to the sagittal axis of the erect body varies in males from 8.8 cm to the right to 2 cm to the left of the axis. In 84 per cent it is to the right of the axis. In females the position ranges from 6 cm to the right to 2.6 cm to the left of the sagittal axis. In 89.5 per cent it is to the right. The most common position in both males and females is from 2.5 cm to 5 cm to the right."

The first portion of the duodenum or cap is covered by peritoneum and, consequently, is freely movable. It begins at the pylorus and ends at the neck of the gall bladder. Gray's "Anatomy" states

It is in such close relation to the gall bladder that it is usually found stained by bile after death, especially on its anterior surface."

The stomach is covered with peritoneum anteriorly and posteriorly, thus allowing complete mobility. It is continuous with the esophagus at its upper extremity, and has a fairly rigid attachment at this point. From here, the stomach is suspended to the diaphragm and liver by the lesser omentum. Gray's "Anatomy" describes this attachment as follows

"The lesser omentum (or gastrohepatic omentum) is the duplicature which extends to the liver from the lesser curvature of the stomach and the commencement of the duodenum. It is extremely thin, and is continuous with two layers of peritoneum which cover, respectively, the antero-superior and postero-inferior surfaces of the stomach and first part of the duodenum. When these two layers reach the lesser curvature of the stomach and the upper border of the duodenum, they join together and ascend as a double fold to the porta of the liver, to the left of the porta the fold is attached to the bottom of the fossa for the ductus venosus, along which it is carried to the diaphragm, where the two layers separate to embrace the end of the esophagus. At the right border of the omentum the two layers are continuous, and form a free margin which constitutes the anterior boundary of the epiploic foramen. The portion of the lesser omentum extending between the liver and stomach is termed the hepatogastric ligament, while that between the liver and duodenum is the hepatoduodenal ligament."

Livingston states

"The manner in which stomach becomes connected with liver is as follows: the bulk of the liver (mesodermal portion) develops within the anterior mesentery, hence this large digestive gland becomes interposed between stomach and anterior abdominal wall so that the stomach no longer appears connected with parietes but with liver. The connecting double peritoneal fold is appropriately termed the lesser omentum (ligamentum hepatogastricum). The gastrohepatic or lesser omentum extends from the entire lesser curvature of the stomach to the under surface of the liver (transverse fissure or porta hepatis)."

¹ Presented before the Radiological Society of North America at the Twenty-second Annual Meeting Nov. 30-Dec. 4 1936 at Cincinnati.

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DISCUSSION

DR PHILIP J HODES (Philadelphia)
Dr Rowe has presented a very difficult subject in an admirable fashion. There is little to say in addition except possibly to point out several features that might be of interest in the technic used in diagnosing small intestinal lesions distal to the ampulla, and to stress certain pitfalls in such diagnoses.

This patient (first slide) was examined on March 27. The proximal jejunum and distal duodenum are situated in the mid-portion of the abdomen.

Examination was made of the same patient fourteen days later (second slide). The same small intestinal loops appear in another portion of the abdomen.

These slides are presented to illustrate a possibility of wrong diagnosis. Radiologists are frequently asked to point out the site of an intestinal obstruction from the plain survey abdominal film by the mere

identification of distended loops. Mistakes in such opinions may occur often as the location of intestinal loops varies in different individuals and even in the same individual from day to day.

The importance of the plain water barium meal in the examination of the small intestine has been stressed repeatedly. Using such a meal, a certain type of small intestinal pattern will be obtained. The barium leaves the stomach in a continuous stream, fluoroscopically, its progress is barely perceptible. Peristaltic rushes are infrequent and bolus formations are not the rule except in the lower ileum.

Under normal conditions the stomach empties the water barium meal in about two hours, although sometimes it may take three hours. The water barium reaches the cecum in approximately from one and a half to three hours, and the entire small intestine is emptied in from four to six hours.

As other speakers have indicated, extrinsic factors such as fear, pain and, in some cases, sensitivity to barium influence the small intestinal pattern.

The importance of fluoroscopy has not been stressed sufficiently in the diagnosis of small intestinal lesions. Roentgenograms taken at hour intervals will not suffice. Fluoroscopic examinations should be made as often as fifteen or, at the most, thirty-minute intervals in such patients. This technic will enable radiologists to pick up transient changes in motility and pattern which may hold the key to a difficult diagnosis. While we recognize this procedure may be tedious, we feel that the results obtained will justify the time consumed.

depends on the mobility of the liver because of its attachment to it

Complete mobility of these organs is necessary for their proper functioning. We wish to quote from Gray's "Anatomy"

"The Stomach (the Pyloric Orifice) —Its position varies with the movements of the stomach. When the stomach is empty the pylorus is situated just to the right of the median line of the body on a level with the upper border of the first lumbar vertebra. As the stomach becomes distended the pylorus moves to the right, and in a fully distended stomach may be situated two or three inches to the right of the median line.

"Alterations in Position —When the stomach is distended, its surfaces, which are flattened when the organ is empty, become convex. The greater curvature is elevated and carried forward, so that the anterior surface is turned more or less upward and the posterior surface downward, and the stomach brought well against the anterior wall of the abdomen.

"When the stomach becomes distended the change in position of the pylorus is very considerable, it is shifted to the right, some two or three inches from the median line, and lies under cover of the liver, near the neck of the gall bladder.

"The Small Intestine (the Duodenum) —In the adult, the course of the duodenum is as follows: commencing at the pylorus, the direction of the first portion depends upon the amount of distention of the stomach and, therefore, upon the position of the pylorus. When the stomach is empty and the pylorus situated at the right of the upper border of the first lumbar vertebra, it is nearly horizontal and transverse, but when the stomach is distended, in consequence of the alteration of the position of the pylorus to the right, the proximal end of the duodenum also becomes altered in position, while the distal end remains fixed and the direction of this portion of the bowel is now anteroposterior. Whether directed transversely or anteroposteriorly, it reaches the under surface of the liver, where it takes a sharp curve and descends along the right side of the vertebral column, for a variable distance, generally to the body of the fourth lumbar vertebra."

Cunningham's "Anatomy," describing the motility and mobility of the stomach, states as follows:

"The Stomach —With distention there comes a general enlargement of the various diameters, and elongation of the whole organ, with a consequent passage of its pyloric portion

to the right beneath the liver, the development of the antrum pylori, and an inclination of its axis from behind downwards and forwards, without any rotation.

"In the gradual passage of the stomach from the empty to the distended condition we may recognize three stages.

"First stage. This commences with an enlargement of the fundus, and is followed by an expansion of the whole cardiac portion, which passes upwards and also to the left towards the diaphragm, displacing the coils of the transverse colon, which lies here when the stomach is empty. The pyloric portion for three or four inches still remains contracted and cylindrical. In this condition the stomach is frequently found after death.

"Second stage. As distention goes on the lesser curvature opens out, the pyloric portion (with the exception of its last inch) expands, but its junction with the cardiac portion usually remains distinct, until distention is almost complete.

"Third stage. A further general expansion of the whole stomach takes place, the diameters of both cardiac and pyloric portions, as well as the length of the organ, are increased, and the great curvature presses forward against the anterior abdominal wall in front, where the restraining influence of the ribs is absent. The pyloric end for about one inch (2.5 cm.) from the pylorus remains narrow (constituting the pyloric canal of Jönnesco), but to the left of this it bulges forward, forming the antrum pylori, which is most distinct at the great curvature. By the increase of the organ in length the antrum is carried a considerable distance to the right beneath the liver—even farther than the pylorus itself—so that the terminal part of the stomach is bent backwards and to the left, in order to reach the pylorus, which latter very rarely passes more than one and a half or two inches to the right of its normal position, namely, in the empty condition, within half an inch (12 mm.) of the middle line.

"The narrow or pyloric end, when the stomach is empty, is contracted and cylindrical, and runs transversely to the right, lying as a rule beneath the left lobe of the liver. During distention it is carried to the right beneath the quadrate lobe, and its terminal part is there directed backwards in order to reach the duodenum. Even in this condition its last inch remains comparatively undistended.

"The Duodenum —When the stomach is distended, the first inch of the duodenum—which is movable on account of its peritoneal covering—is carried to the right with the pylorus, and thus brought into line with the second or

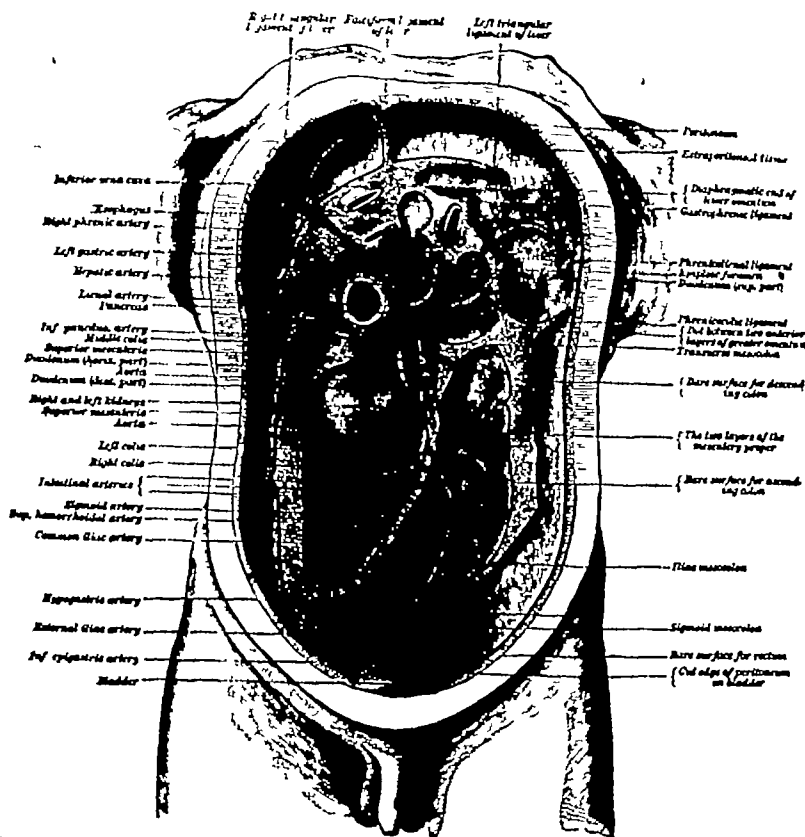


Fig 1 See caption under Figures 2 and 3

This suspension of the stomach to the liver allows it to move with the liver

The liver also has a peculiar method of suspension, allowing considerable range of mobility. Cunningham's "Anatomy" describes the attachment of the liver as follows:

"Posterior Area of the Parietal Surface"

(1) The uncovered area of the right lobe is a considerable portion of the back of the right lobe—varying from one and one-half to two and one-half inches in width, and from three to four inches in transverse measurement—which corresponds to the interval between the two layers of the coronary ligament, and is devoid of peritoneum. Over this uncovered portion, which looks more inward than backward, the liver and diaphragm are in perfect contact, and are united by areolar tissue."

Piersol states the following in regard to the mobility of the liver:

"Coincidentally with the descent of the viscus, it undergoes a rotation or tilting forward so that its diaphragmatic surface is in contact with the abdominal wall."

This peculiar attachment of the liver allows a combination of upward and downward, and inward and outward displacement, which is accompanied by rotation. The actual position of the liver and its attached gall bladder varies markedly with the habitus, from the sthenic to the asthenic type, changes in body weight, presence of ascites, pregnancy, uterine, or ovarian tumors, etc. It undergoes a similar change in position in passing from an empty stomach to a full one.

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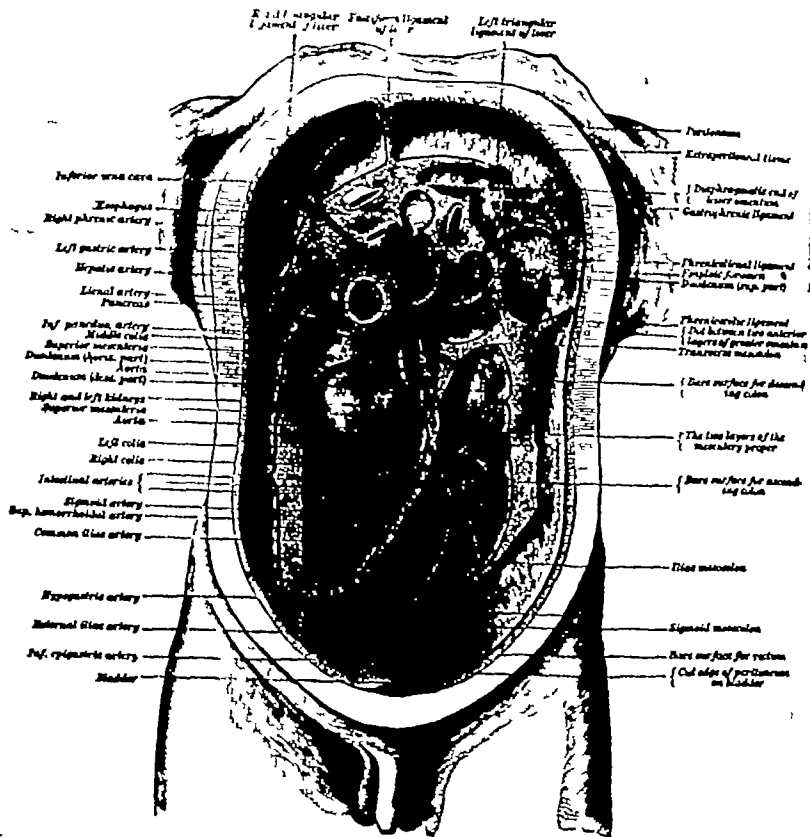


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We have included this detailed description of the attachment of the organs in the upper right quadrant to show how they adjust themselves to different types of habitus, changes in body weight, pregnancy, and various pathological conditions, and especially how they adjust themselves to a full meal and to active peristalsis of the stomach

In two previous articles we demonstrated by films and tracings from films, how the normal visualized gall bladder moved upward and outward from one and one-half to two inches after the taking of a solid meal, and also, how the intimate contact of the antrum and cap with the normal gall bladder, when the stomach was visualized, could not help but exert sufficient pressure to empty the gall bladder in the time and manner in which it is known to empty

McMaster and Elman have shown in their work on dogs, with a tube inserted in the gall bladder, that immediately, or as they state, practically *at once* upon giving food, the bile would rise high in the tube Boyden describes the "initial response" as follows

"Perhaps the most striking feature of the reaction of the gall bladder to food is the very short latent period of contraction 14 out of 17 patients showed a marked diminution of volume within the first two minutes after food entered the mouth "

We have shown how the pressure of the filled stomach and cap, in intimate contact with the gall bladder embedded in the liver, exert sufficient pressure to displace it upward and outward from one and one-half to two inches This is the most logical explanation of the effect on the gall bladder immediately on taking food Repeated waves of peristalsis cause additional pressure on the gall bladder We believe these are the main factors in emptying the gall bladder

We have also demonstrated that if this intimate contact of the antrum and cap

with the gall bladder is disturbed by overweight or under-weight, pregnancy, etc., the gall bladder will not empty but will give rise to symptoms A careful check of the patient's history will show that a large percentage of gall bladder symptoms date back to changes in body weight The old statement of "fair, fat, and forty" is only partly true Of course, fat is apt to accumulate at forty However, the gall bladder is as prone to disease in the asthenic as in the sthenic types

Even when the gall bladder is visualized and normal in density at six hours, it is almost certain, if its mobility is limited, that is, if it does not move upward and outward from one and a half to two inches after a full meal, that it will not empty in 24 hours

Occasionally, after giving the gall bladder dye test, which we routinely do by the intravenous method, the six-hour film will show no sign of a gall-bladder shadow After a solid meal is given, some of these gall bladders will be visualized and are normal in shape, size, and density, and will empty in 24 hours For several years we were at a loss to explain this peculiar condition Why should some gall bladders visualize after a full meal but not before, be normal in density, and empty in a normal manner? Were they diseased gall bladders, and should they be removed? Since we have been paying more attention to the mobility of the organs in the upper right quadrant, we have reached the conclusion that in this type of gall bladder there is a kinking of the cystic duct which is straightened by the full meal pressing the gall bladder upward and outward, as we have described above Many roentgenologists do not carry the test further if the gall bladder does not fill, logically enough perhaps, thinking it is foolish to give a meal to empty a gall bladder that does not fill Furthermore, a solid meal will push the gall bladder farther upward and outward than a liquid meal We believe that a solid meal should always be given, whether the gall bladder is visualized or not A fat meal is absolutely unnecessary to produce empty-

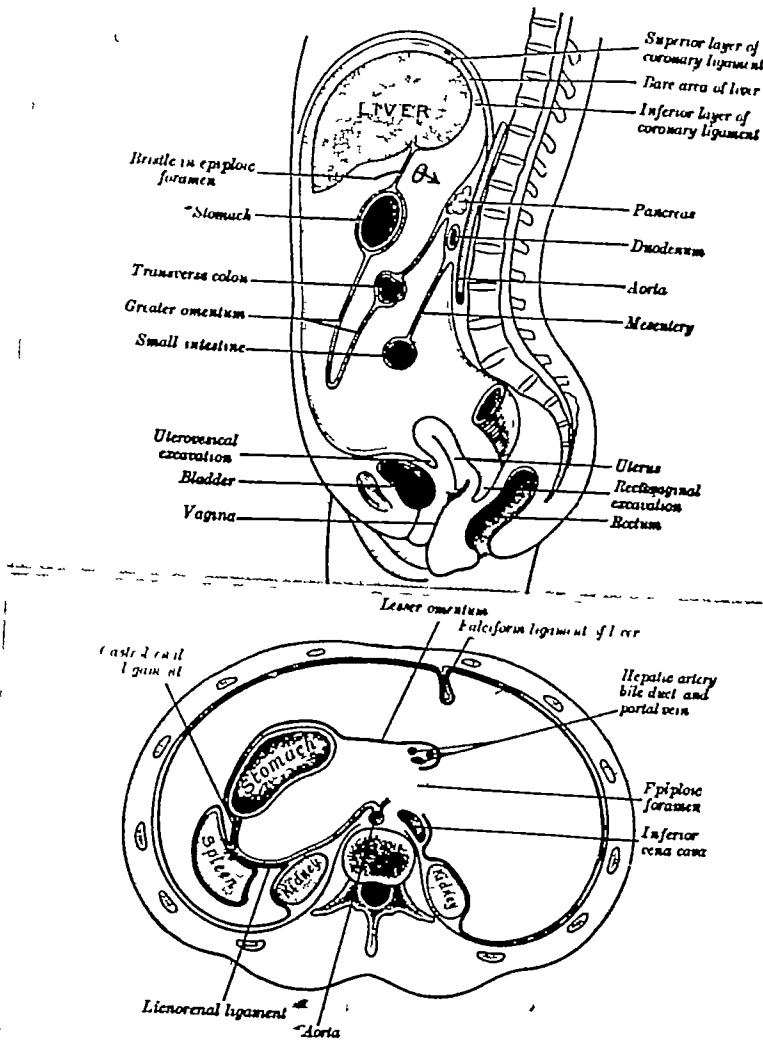


Fig 2 (above)

Fig 3 (below)

Figs 1 2 and 3 (Gray's Anatomy' 22nd Edition) These illustrate the attachment of the liver to the posterior abdominal wall and the attachment of the stomach to the liver which permits the mobility of these organs

terminal half, which is always directed backwards. Hence the whole of the first portion of the duodenum is directed backwards when the stomach is full."

In a previous article we called attention to the effect of mobility of the gall bladder on the cystic duct, and the action of the cystic duct as follows

"The cystic duct is a hollow fibro-muscular tube lined by a redundant mucous membrane connecting the common duct with a movable organ (the gall bladder attached to the liver). Like any mechanical attachment between

movable parts, it must be able to handle the play between them. After a full meal, the gall bladder is pushed upward and outward from one to two inches by the full stomach, and undergoes a certain amount of rotation because of its attachment to the liver. This straightens the cystic duct and allows it to readily empty into the common duct, as stated by Jacobson and Geydesen. We, ourselves, have repeatedly demonstrated in rabbits and guinea pigs that moderate traction on the gall bladder will straighten the cystic duct, and readily empty the gall bladder. When the stomach is empty, the muscular portion of the duct assumes some modification of the S-shape by its own con-

tractability, and the redundant mucous membrane, if rotated, would assume a spiral shape, producing the valves of Heister "

We have included this detailed description of the attachment of the organs in the upper right quadrant to show how they adjust themselves to different types of habitus, changes in body weight, pregnancy, and various pathological conditions, and especially how they adjust themselves to a full meal and to active peristalsis of the stomach

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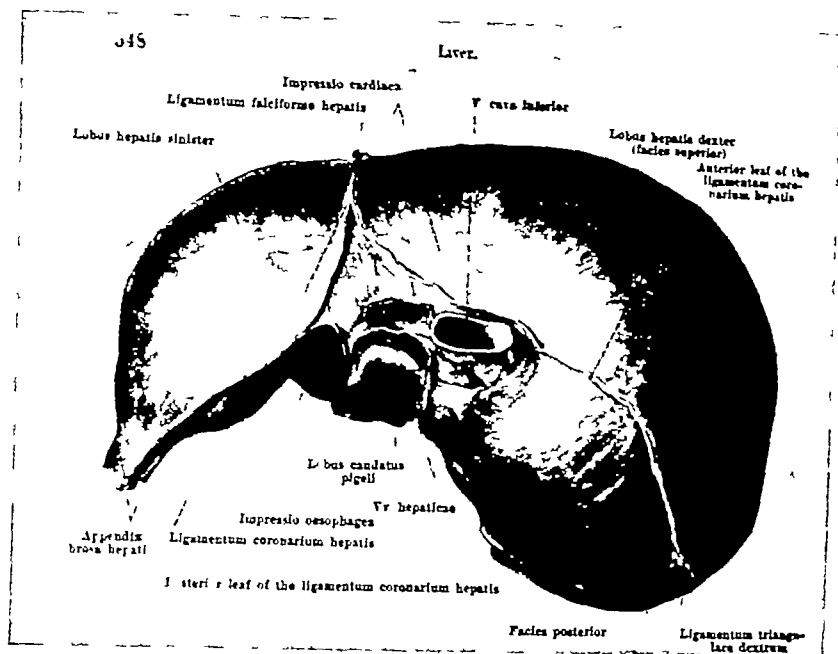


Fig 4 (Spalteholz, Werner 'Hand atlas of Human Anatomy,' 1923) Shows the limited amount of retroperitoneal attachment of the liver. This limited attachment gives it free mobility.

ing of a normal gall bladder, and does not even simulate normal conditions.²

Another problem of mobility enters into the above type of cases. Why should the gall-bladder shadow be normal in density immediately after eating? (The patient is instructed to eat a normal solid meal at some nearby restaurant, and return at once.) In our experience, it takes at least three hours for the gall bladder to concentrate the dye to a normal density.

All physiologists agree that bile is secreted more or less continuously, but more profusely during gastric digestion. What part does the pressure of the filled stomach on the liver, as described above, have on the secretion of bile, or on expressing it from the small and large biliary ducts and even from the liver cells? Apparently, in the above type of cases, the bile had been secreted and concentrated, but did not enter the gall bladder until the cystic duct

was straightened by the pressure of the filled stomach against the liver. We have shown that the liver with its attached gall bladder, moves upward and outward, and rotates because of the pressure of a filled stomach on the liver. Interference with the mobility of the liver due to pathological conditions in the upper right quadrant, should have an unfavorable action on the function of the liver, if the above deductions are correct.

Many gall bladders giving symptoms, if not of too long a duration, can be restored to normal if the weight is restored to normal.

Experiments on pregnant animals have shown that the gall bladder will not function in many of them, but will function normally after delivery. The same is true of many pregnant women, if stones have not formed because of the failure of the gall bladder to empty. We believe this improvement is caused by the restoration of normal relations and free mobility of these organs.

Mobility of the Pylorus and Cap—According to Gray's 'Anatomy,' as quoted

²In RADIOLOGY, Vol. 25, page 558 we presented films of the same individual in which barium and buttermilk emptied the gall bladder in 29 minutes and barium and eggs and cream required one hour and fifteen minutes to empty it.

above, when the stomach is empty, the pylorus is just to the right of the median line, and when fully distended, it may be two or three inches to the right of the median line. One should always check the mobility of the pylorus during a fluoroscopic examination and, if immovable, a serious effort should be made to determine the cause. If the pylorus is always found close to the mid-line in a series of films of the filled stomach, there is usually some pathology in this region to account for it, such as adhesions, cholecystitis, ulcers, etc.

In films and under the fluoroscope, under normal conditions of mobility, the descending portion of the duodenum drops vertically. We often see the descending portion pulled to the right. The probable explanation of this is, that in inflammatory conditions in this area, the stomach will not tolerate food, and consequently, the cap is immobilized by adhesions in the empty position close to the mid-line. This gives the effect of the descending portion being pulled to the right, when, in reality, the cap is held to the left close to the mid-line.

THE PART PLAYED BY MOBILITY IN PERISTALSIS OF THE STOMACH AND DUODENAL CAP

Alvarez states

"Another characteristic of smooth muscle in hollow organs is its responsiveness to tension. Most of the motor activities of the stomach and bowel are brought about and regulated largely by the internal pressure due to the presence of food or gas. Cannon has shown that the rhythmic segmentation in the small intestine is due simply to the fact that those muscle fibers which are stretched tend to contract. Their contraction increases the pressure in neighboring segments, and so the process goes on. Cannon has shown also that the waves in the stomach tend to appear at those places where the internal pressure balances the local tone of the muscle.

"In the human stomach, waves appear about once in twenty seconds. Carefully taken serial plates reveal the fact that these waves begin near the cardia. They travel as shallow ripples until either proper pressure conditions or the presence of the peculiar antral muscle causes them to break into deep waves. Ordinarily we see only one or two waves at a time, but in the

presence of a diseased gall bladder or an ulcerated duodenum the stomach often gets so irritable that four or five deep waves course over it at one time. Reverse waves are seen only under pathological conditions. During the first stages of starvation there appear the powerful, so-called hunger contractions."

Alvarez also states

"The gastric waves do not cross the pylorus, so far as we can see."

Cannon originally advocated the theory that the opening and closing of the pyloric sphincter was under acid control. However, this theory will not account for the emptying of the stomach in the absence of hydrochloric acid, as in achylia gastrica, and has been discarded.

Cole describes the motor phenomena of the stomach, pylorus, and cap as follows

"The gastric motor phenomenon is complex rather than simple and is composed of the progression of the peristaltic waves pyloruswards and a systole and diastole, and it may be considered in the form of a cycle similar to the cardiac cycle. The stomach assumes a series of shapes and eventually assumes the same shape that it was approximately fifteen or twenty seconds earlier. This is referred to as a gastric cycle.

During the systole of each gastric cycle, when the pressure against the proximal surface of the pyloric valve is greatest, the pyloric sphincter is partly opened, either actively or passively, and the chyme is propelled into the reservoir cap, and during the stage of diastole when the gastric pressure is diminished the sphincter may be closed to prevent the chyme from falling back into the stomach.

"The duodenum is replenished from the reservoir cap where the finishing touch of proteid digestion is applied to a small amount of chyme. The cap is evacuated by a broad peristaltic wave, independent of the gastric peristalsis, which forces the chyme through the duodenum in 'finger-like masses'."

Wheelon and Thomas state

"Such observations definitely establish the antrum as an organ of special motility, the purpose of which is to mix the ingesta and bring it into contact with the gastric juices, and to propel the semidigested chyme onward into the duodenum. Some time before the antrum enters upon its held contraction the sphincter begins to rapidly contract and reaches its maximum, usually at a time of marked relaxa-

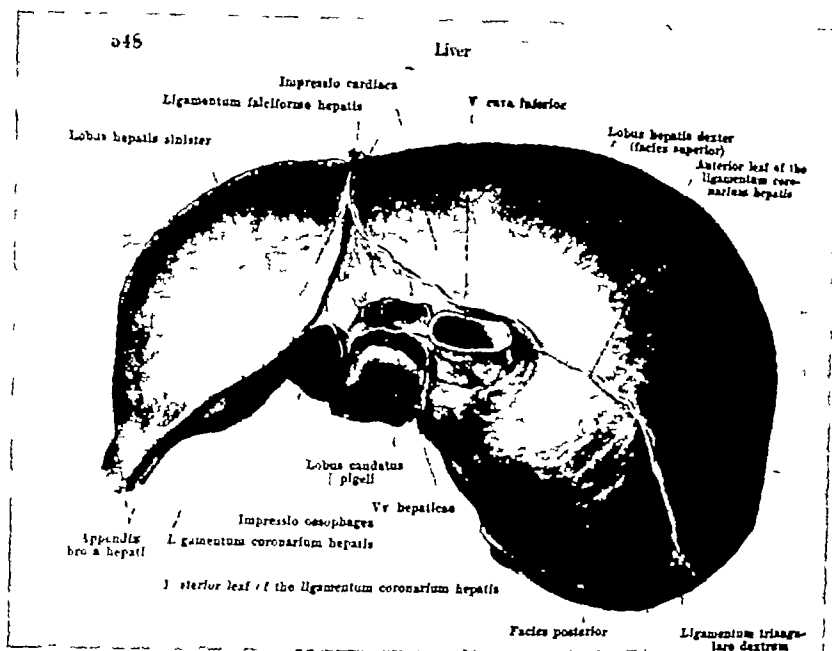


Fig 4 (Spalteholz, Werner 'Hand atlas of Human Anatomy,' 1923) Shows the limited amount of retroperitoneal attachment of the liver. This limited attachment gives it free mobility.

ing of a normal gall bladder, and does not even simulate normal conditions.²

Another problem of mobility enters into the above type of cases. Why should the gall-bladder shadow be normal in density immediately after eating? (The patient is instructed to eat a normal solid meal at some nearby restaurant, and return at once.) In our experience, it takes at least three hours for the gall bladder to concentrate the dye to a normal density.

All physiologists agree that bile is secreted more or less continuously, but more profusely during gastric digestion. What part does the pressure of the filled stomach on the liver, as described above, have on the secretion of bile, or on expressing it from the small and large biliary ducts and even from the liver cells? Apparently, in the above type of cases, the bile had been secreted and concentrated, but did not enter the gall bladder until the cystic duct

was straightened by the pressure of the filled stomach against the liver. We have shown that the liver with its attached gall bladder, moves upward and outward, and rotates because of the pressure of a filled stomach on the liver. Interference with the mobility of the liver due to pathological conditions in the upper right quadrant, should have an unfavorable action on the function of the liver, if the above deductions are correct.

Many gall bladders giving symptoms, if not of too long a duration, can be restored to normal if the weight is restored to normal.

Experiments on pregnant animals have shown that the gall bladder will not function in many of them, but will function normally after delivery. The same is true of many pregnant women, if stones have not formed because of the failure of the gall bladder to empty. We believe this improvement is caused by the restoration of normal relations and free mobility of these organs.

Mobility of the Pylorus and Cap—According to Gray's 'Anatomy,' as quoted

²In RADIOLOGY, Vol. 25 page 558 we presented films of the same individual in which barium and buttermilk emptied the gall bladder in 29 minutes and barium and eggs and cream required one hour and fifteen minutes to empty it.

(duodenal cap) When a wave in an intense phase reaches the pyloric antrum, the sphincter relaxes before it, and as the pressure in the antrum is high, its contents escape into the duodenum. The contraction wave then involves the sphincter and closes it."

In 1911, Cole concluded that pathology in the upper right quadrant had its effect on peristalsis. He states

"They do, however, represent various types of gastric peristalsis in stomachs that show no radiographic evidence of a pathological lesion in or around the stomach or duodenum, and are, therefore, called 'unobstructed,' in contradistinction to those in which the peristaltic contraction or wave is obstructed by early carcinoma, ulcers, or adhesions from gall-bladder infection."

Luckhardt, Phillips, and Carlson state

"Fluoroscopic examination of the stomach of man while recording simultaneously graphically the motor activity of the stomach shows that the pylorus opens for the ejection of chyme with arrival at the pylorus of powerful advancing rings of constriction aided possibly by a general increase in tone of the stomach musculature as a whole."

Cole, in discussing adhesions, states

"The manner in which the cap lies between the gall bladder on the right and the common duct on the left, and the fact that slight adhesions prevent its normal dilatation, must always be borne in mind.

"Adhesions are caused by gastric or duodenal ulcer, or gall-bladder infection, with or without calculi, in a large percentage of cases, and therefore they generally indicate that one of these conditions is present or has existed. From the location and character of the adhesions one can sometimes tell which of these conditions has caused them."

Lack of expansion of the antrum is often seen in gall-bladder disease. George and Leonard state

"There is, however, one type of spasm that in our experience is so commonly associated with gall-bladder disease that we have come to consider it when present as fairly reliable evidence. This type of spasm affects the antrum of the stomach. Usually the distal third of the stomach becomes uniformly contracted, producing a tubular outline an inch or so in diameter, the proximal two thirds maintaining its normal diameter."

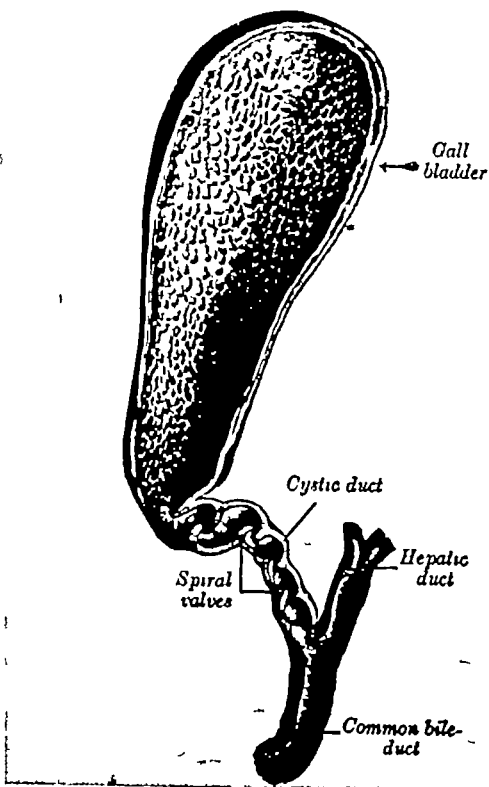


Fig 6 (Spalteholz, Werner Hand-atlas of Human Anatomy, 1923) Shows the convolutions of the cystic duct. When the gall bladder moves upward and outward from 1.5 to 2 inches after a full meal, by straightening of the convolutions the duct permits this range of motion.

Carman stated

"Spasms of the gastric musculature occur frequently in association with cholelithiasis, cholecystitis and pericholecystitis—so frequently that the gall bladder should be suspected first of all whenever spastic eccentricities of the stomach are noted. The spasmodic manifestations in the stomach may be slight or extensive, ranging from a transient incisure or a temporary hour-glass to a regional spasm with considerable deformity. An especially striking type of the latter is that in which the entire pars pylorica is contracted to a narrow, stiffened, sometimes palpable, tube."

From the above review of gastric peristalsis, it is evident that distention will produce contraction. Contraction of a segment produces distention in the succeeding segment, followed by its automatic contraction. When this wave reaches the pylorus, it distends the muscles entering

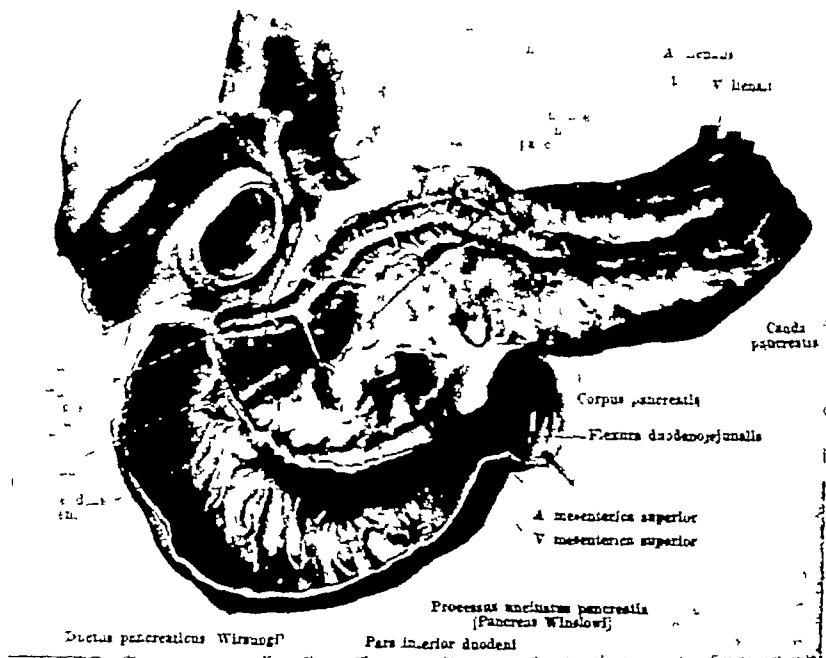


Fig 5 (Spalteholz, Werner "Hand atlas of Human Anatomy," 1923) Shows the relation of the antrum to the gall bladder and cystic duct. Pressure of a full meal pushes the gall bladder upward and outward from 1.5 to 2 inches, and straightens the cystic duct beside exerting direct pressure upon the contents of the gall bladder.

tion of the antrum. The sphincter then relaxes and remains quiet until a second positive phase is well initiated in the antrum. Hence, the sphincter is open during the greater part of the antral contraction and actively closed while the antrum is relaxing."

They further state

"Our results, along with those of Cole and Luckhardt, Phillips, and Carlson, demonstrate that the activities of the pyloric sphincter, at least in great part, are dependent upon the activities of the antrum. That is, the impulse to contract in the antrum during digestive processes is propagated into the sphincter, thereby causing it to contract at a time of relaxation of the antrum and to relax because of the arrival of a wave of relaxation over the antrum. Such conditions indirectly lead to the conclusion that acid if it acts to regulate the 'pylorus' must also act in a similar way upon the antrum and stomach as a whole, for, as shown above, motility of the antrum determined motility of the sphincter."

Starling states

"The wave as it travels along exhibits every two to three seconds the rhythmic fluctuations in intensity common to most plain muscle contractions, and when a wave at a phase of increase reaches a point about one inch from the pyloric canal it is so marked that part of the pyloric antrum becomes almost completely separated from the rest of the stomach. The part thus cut off then diminishes in size in every direction, part of its contents being forced through the pyloric canal, while the remainder escapes back as an axial reflux stream into the stomach. The waves recur at regular intervals of fifteen to twenty seconds, and three or four are present simultaneously. They continue without cessation until the stomach is empty—from one to four hours after the meal, according to its bulk and composition."

"It has indeed been thought that the acidity of the gastric contents exercises a direct inhibitory action on the pyloric sphincter, but recent work has shown that this is not the case. It appears more likely that the onward passage of gastric contents depends on two factors, first, the relaxation of the pyloric sphincter, and second, the relative pressures in the pyloric antrum and the first part of the duodenum."

the mobility and dilatation of the antrum, thus inhibiting peristalsis

Normal peristalsis in the antral portion of the stomach consists of vigorous waves, of contraction and dilatation, both of which are essential to peristalsis. The wave is started by over-stretching. The contraction of a segment causes the succeeding portion to expand, which automatically contracts because it has been stretched. This is accompanied by a marked displacement of the antrum and pylorus to the right, which requires considerable range of motion or mobility. It is the inherent nature of an involuntary muscle that stretching and expansion are necessary before it can contract. Thus, anything interfering with its expansion and mobility will inhibit peristalsis. Vigorous contractions of the antrum are necessary to overcome the pyloric sphincter, and any inhibition of gastric peristalsis will delay emptying of the stomach, even though there is no organic narrowing of the pyloric sphincter.

Distention of the cap is, likewise, necessary to initiate peristalsis in the duodenum, and free mobility is necessary for its proper function.

Alvarez says

"The duodenal cap tends to remain filled during the early stages of digestion. This may be due to the low rhythmicity of the muscle in that region, to its thinness and weakness (in man), to its firm attachment to the mucous membrane, and perhaps to the peculiar festoon-like arrangement of the fibers."

May we suggest a probable explanation as to why the cap tends to remain full? It requires a certain amount of distention to initiate a peristaltic wave. It requires several gastric peristaltic waves to distend the cap sufficiently, so that it will initiate a peristaltic wave. When this occurs, the cap is evacuated at once. Of necessity the cap would be filled, or partly filled, the major portion of the time, as it empties quickly and fills slowly.

CONCLUSION

We have shown how the suspension of the stomach and duodenal cap to the liver,

and the attachment of the liver by its posterior and inner border to the diaphragm, permit the marked mobility of these organs which is so necessary for their proper functioning. We have shown how limitation of this mobility interferes with the function of the liver, gall bladder, biliary duct system, stomach, and duodenum.

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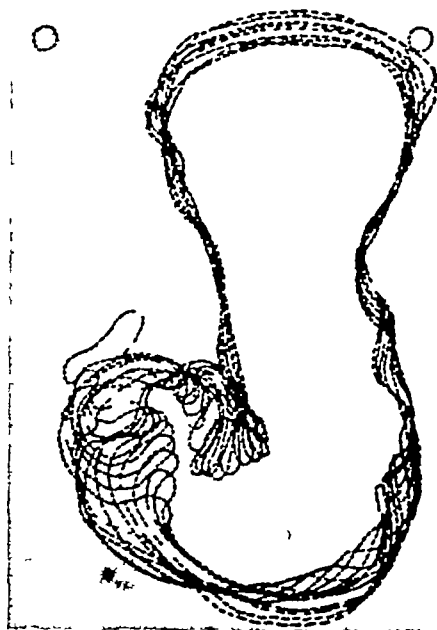


Fig 7 (Kaestle, C., Rieder, H., and Rosenthal Phil J Arch Roentgen Ray, 1911, 15, 3) Shows the range of motion of the stomach and particularly the antrum, during peristalsis. Any limitation of this mobility interferes with normal peristalsis and emptying of the stomach.

into it, allowing some food to pass, and after distention, it automatically contracts the same as the other segments of the stomach. Peristaltic waves are not transmitted from the stomach to the duodenum. Consequently, new peristaltic waves arise in the cap by the same method. When sufficient food has passed through the pylorus into the cap to produce distention or dilatation, peristaltic waves will be originated there. Stretching, due to distention of the smooth muscle, is a fundamental part of peristalsis, and requires considerable freedom of motion along the axis of transmission. In the antrum the waves are especially deep, and all roentgenologists have observed the normal antrum bulge and swing to the right during active peristalsis. Freedom of motion and room for expansion are necessary for active peristalsis. Too little attention has been paid to the inhibition of gastric peristalsis due to immobility in this region.

Gastric Retention—David M. Beckman,

in summarizing gastric retention in cases operated on at the Mayo Clinic in 1922, says that, in 582 patients operated on for duodenal ulcer, gastric retention was present in 93 cases (16 per cent), and in 97 cases operated on for gastric ulcer, gastric retention was present in 22 (22.6 per cent). In the 115 cases of gastric retention, actual narrowing or obstruction of the pyloric ring was demonstrated at operation in only 22.7 per cent of the gastric ulcers and 46 per cent of the duodenal ulcers.

Eusterman and Balfour report in 778 surgically verified cases of duodenal ulcer at the Mayo Clinic, gastric retention or pyloric obstruction was recorded in 20 per cent. In 324 cases of chronic benign gastric ulcer, retention was noted in 29 per cent. In 35 per cent of the cases in which the site was definitely recorded by the surgeon, the gastric ulcer was remote from the pylorus.

In our experience, gastric retention of from one-third to one-fourth is a very common complication of gall-bladder disease. In a great many cases, even though there is no gastric retention of food, there is a scattering of the meal through the jejunum and proximal loops of the ileum, showing a definite delay in leaving the stomach. Gall-bladder disease definitely inhibits peristalsis as is seen by the long, narrow antrum and lack of dilatation of the antrum, so long noted by roentgenologists in many cases of advanced gall-bladder disease.

We have shown in previous articles that, if the gall bladder does not move upward and outward from one and one-half to two inches after a full meal of solid food, the gall bladder will not empty in twenty-four hours, and *vice versa*, if it does have the above mobility, it will empty normally.

We have seen several cases of gastric retention following cholecystectomy that were not present before operation. We have also seen other cases of gastric retention, with adhesions to the antrum, which did not cause any narrowing of the antrum. We believe many adhesions cause delay in emptying the stomach, by interfering with

this is not proof of the fact that all bile is evacuated by this means

Failure of the gall bladder to function properly with changes of weight in pregnancy, while it is common, is not an absolutely constant finding, and I think that we cannot attribute all of the biliary tract difficulties which these patients have to the increase of weight in the pregnancy, and, therefore, to mechanical factors

There are some questions which I think can be raised concerning this mechanical theory as an all-inclusive one. For example, the cases of gastro-enterostomy in which pyloric stenosis is present and in which the food does not enter—at least does not distend—the pyloric antrum. Certainly all of these cases do not show biliary tract pathology. As a matter of fact, I recently have seen one in which the dye test showed perfectly normal visualization of the gall bladder and normal emptying and yet no part of the meal in the upper part of the intestinal tract approached the gall bladder.

I feel, therefore, that while these mechanical factors which Dr Newcomer has described are very valuable factors and probably are the missing link that we have been looking for, still we must take into consideration all other factors with regard to the emptying of the gall bladder.

DR NATHAN B NEWCOMER (closing)
I wish to thank Dr Bell for his discussion.

In regard to the musculature of the gall bladder, it is very ineffectual. The gall bladder will empty with or without innervation in the presence of food. The main thing that stands out in emptying of the gall bladder is its emptying when food is taken.

A fat meal is unnecessary in emptying the gall bladder.

Several authorities have shown that this does not occur slowly, the major response occurs at once, within a minute or two, and I have tried to show you what happens in the mechanical relations of the gall bladder and stomach during that minute or two.

Immediately upon filling the stomach, it moves over to the right and up. It pushes the gall bladder up and to the right about two inches. There is an intimate contact between the antrum and cap, and the gall bladder, causing local external pressure on the gall bladder. If I had had time to show my slides, I would have shown that a normal gall bladder will be contacted by the antrum and cap.

This first rise in pressure, that McMaster and Elman describe, occurs immediately when the gall bladder is pressed upon by the filled stomach, including the antrum and cap. The initial response occurs in two minutes, and this is what happens during that two minutes. The stomach pushes firmly against the gall bladder and cap and subsequently peristalsis increases this pressure. I do not claim this is the only factor in emptying. In the cases of gastro-enterostomy and gastrectomy, it is very questionable whether the gall bladder will stay normal over a period of time because of the alteration in the relations of these organs following the operation.

Several authorities have shown that the greatest response to food in the stomach occurs within a minute or two after food has entered the stomach, and we have shown what mechanical changes occur in the relations of the stomach in that time.

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DISCUSSION

DR ALFRED L L BELL (Brooklyn, N Y) Dr Newcomer has covered very thoroughly in his paper all of the mechanical aspects of mobility and motility in gall-bladder function

I think we are all dissatisfied with the present theories with regard to biliary tract function, particularly with regard to gall bladder emptying, and anything which will serve to clear up the doubts which we have had concerning these theories helps considerably

Dr Newcomer has stressed one factor which is a very valuable one However, I feel that we cannot exclude all other possibilities with regard to gall-bladder emptying in favor of the mechanical theory

We know, for instance, that the gall bladder has a very complete musculature and that this musculature is properly innervated We know that under certain circumstances, at least, this musculature seems inadequate to produce proper emptying, and we know that emptying does take place, or at least intra-colecystic pressure increases, experimentally, after ingestion of a meal even when all nerves to the gall bladder have been severed

We are all dissatisfied, I think, with the absorption theory of gall-bladder emptying, that is, that bile is absorbed only from the gall bladder and is not emptied at all by the cystic duct Bile salts have been found in the vessels from the gall bladder but

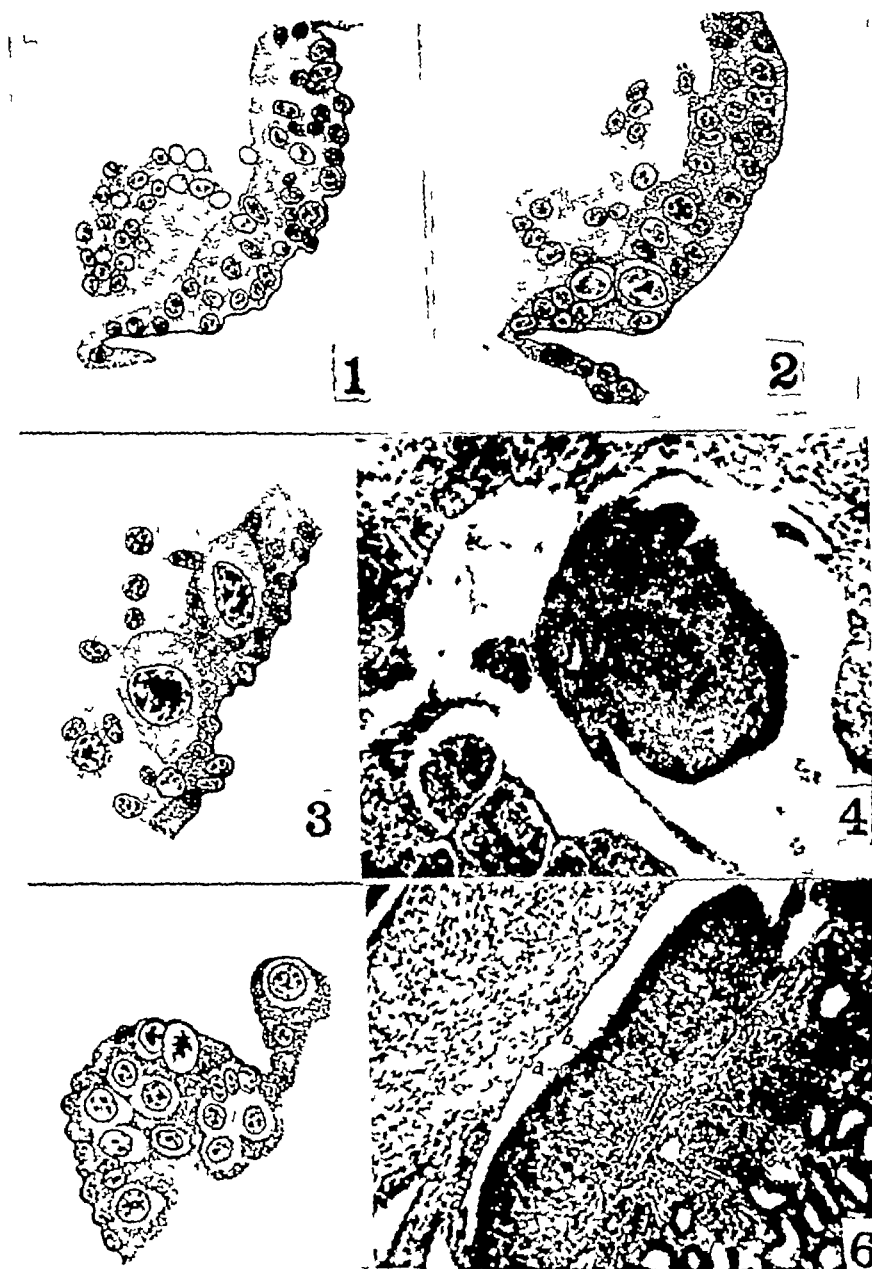


Fig 1 Section through the germinal epithelium of a three day-old chick embryo irradiated with 550 r at 20 hours incubation. Note the presence of transitional germ cell stages and the absence of fully formed germ cells ($\times 950$)

Fig 2 Section through the germinal epithelium of a three day-old chick embryo irradiated with 600 r at 22 hours incubation. Note the presence of both transitional stages and fully formed germ cells ($\times 950$)

Fig 3 Section through the germinal epithelium of a three day old chick embryo irradiated with 550 r at 20 hours incubation. Note giant germ cells ($\times 950$)

Fig 4 Transverse section through a testis of a six day-old chick embryo irradiated with 600 r at 18 hours incubation. Note germinal epithelium with fully formed germ cells and testis cords ($\times 120$)

Fig 5 Section through the germinal epithelium of the same testis as shown in Figure 4 ($\times 950$). Note fully formed germ cells and transitional stages

Fig 6 Transverse section through the ovary of a six-day old chick embryo irradiated with 550 r at 20 hours incubation. Note fully formed germ cells at a and b ($\times 120$)

AN ATTEMPT TO CASTRATE THE CHICK EMBRYO WITH X-RAYS

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From the Department of Anatomy, Loyola University School of Medicine

INTRODUCTION

THE theory of early germ cell segregation in animals was advanced by Nussbaum, in 1880. Swift (7) contended that the primordial germ cells in the chick embryo arise extra-embryonally during the primitive streak stage from an area known as the germinal crescent. The large endodermal cells enter the adjacent mesoderm and pass to the gonadal region. As such, they enter the germinal epithelium and become the definitive germ cells of the chick embryo. Benoit (1) attempted to destroy the germinal crescent by ultra-violet irradiation. Chick embryos from 18 to 24 hours old were irradiated for from 10 to 15 minutes and then allowed to incubate for about two days. Histologic examination revealed that there were no germ cells in the gonadal region. Essenberg and Garwacki (4) reported the finding of transitional stages in germ cells, indicating that germ cells originate from the peritoneal epithelium in the chick embryo. These conflicting data induced the present writer to undertake the study of the effect of x-rays on the germinal crescent.

MATERIALS AND METHODS

Eggs of white and brown leghorn chickens were used for this experiment. They were irradiated at 16, 18, 20, 22, and 24 hours of incubation, each group being treated with 400, 500, and 600 units of x-rays. After irradiation the eggs were permitted to incubate at the ages of two, three, and six days. The material was fixed in Bouin's fluid, embedded in paraffin, and sectioned from 6 to 8 microns in thickness. Heidenhain's iron hematoxylin was used for staining.

The x-ray machine¹ used was mechanically

rectified and provided with a Landauer roentgenometer. A universal Coolidge therapy tube was used. The set-up of the machine for the entire experiment was as follows. The kilovolt meter was set at 96, which delivered 112 peak kilovolts as measured by the sphere gap, the focal distance was 10 inches, the filter was equivalent to 4 mm aluminum, the roentgenometer was kept at 3.2 microamperes, which, by calculation, gave 0.6 r per second. The desired r, or dosage, was obtained by varying the time of exposure.

A specially designed irradiation box (4), was used for this experiment. In it was incorporated a portable incubator, a candler, and a scattered-ray absorber.

RESULTS

Embryos Two Days Old—In this group are included embryos from 24 to 32 hours after irradiation. Specimens treated with lethal doses of x-rays show advanced cellular decomposition. Embryos, having received non-lethal dosages, show definite signs of recovery, mitosis takes place, and cells assume a more normal appearance, although pycnotic and degenerating cells are numerous. Unmistakable primordial germ cells have not been identified in irradiated chick embryos. In this stage of development the lateral wings of the splanchnic mesoderm have not fused to form the dorsal mesentery, yet there is a definite indication of formation of germinal epithelium.

Chick Embryos Three Days Old—Embryos irradiated with lethal doses are in advanced stages of degeneration. Embryos treated to non-lethal dosage may be divided into two classes: one that presents various degrees of malformation, and the other in which the embryos are, to all appearances, normally formed. The abnormalities may be of various kinds: from the lack of a digit to the lack of whole parts.

¹ "Type C" model made by the Standard X-ray Company, Chicago

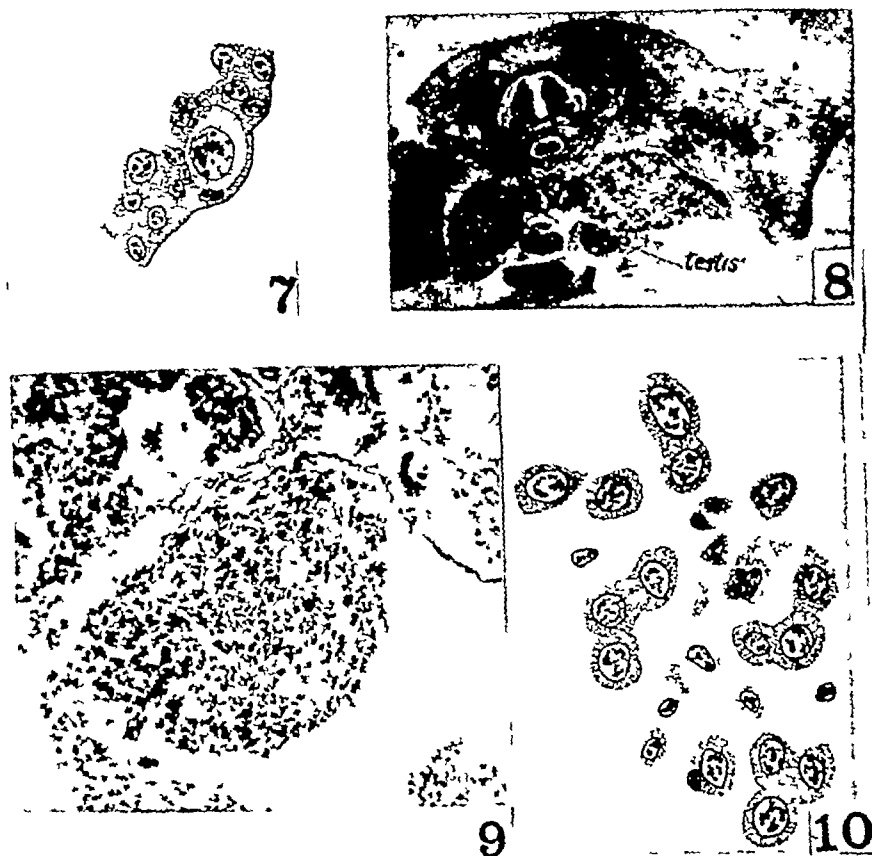


Fig 7 Section through the germinal epithelium of the same ovary as shown in Figure 6 ($\times 950$) Note fully formed germ cell and transitional stages

Fig 8 Transverse section through the gonadal region of six day-old chick embryo having received a lethal dose of x rays Note testis ($\times 20$)

Fig 9 The same section as shown in Figure 8 with testis ($\times 100$) Note rarified tissues

Fig 10 The same section as shown in Figure 8 ($\times 950$) Note fully formed germ cells and transitional stages

no direct relation to the formation of definitive germ cells in the chick embryo. These originate *de novo* from cells of the peritoneal epithelium. It is also believed that the above facts explain Benoit's findings. His chick embryos were too young, about 56 to 72 hours, to find fully formed germ cells, and his material was probably not sufficiently abundant to detect the difference.

SUMMARY AND CONCLUSIONS

The eggs of domestic hens were x-rayed at the primitive streak stage of development with 100, 500, and 600 r and allowed to incubate at the ages of two, three, and six days. The findings are as follows:

(1) With the set-up of the x-ray machine used in this experiment and the embryos between 16 and 24 hours of age, 600 r is lethal to about 96 per cent of all embryos irradiated.

(2) Most of the embryos irradiated with a lethal dose die shortly after irradiation, some survive for several days.

(3) Embryos irradiated with a non-lethal dose show definite signs of recovery 24 hours after treatment.

(4) In embryos three days of age, the germinal epithelium is in formation. Fully formed germ cells are seldom found, intermediate steps are numerous.

(5) With the exception of a slight reduc-

of the body (2) In the normally formed chick embryos, the germinal epithelium is in the process of formation Early stages of germ cell transformation from peritoneal epithelium have been found in all specimens studied (Fig 1) However, whether fully formed or precocious, germ cells are seldom found in three-day-old chick embryos They may be found in a few places of the gonad, as shown in Figure 2, but there are embryos in which none are found Occasionally, unusually large germ cells, from three to four times the normal size, are encountered (Fig 3) These have the appearance of precocious oocytes, they have not been observed in normal material at this early stage of development and are probably the result of the x-rays

A Six-day-old Embryo having Received a Non-lethal Dose—The gonads at this stage of development do not appear to differ from the non-irradiated ones except in size On the average, the treated are slightly smaller than the non-treated gonads (Figs 4 and 6) The germinal epithelium is thick and contains not only fully formed germ cells, but all the intermediate stages as well (Figs 5 and 7) The medulla is composed of cords in which lumina have already formed (Fig 4), and in which all the cell types, including fully formed germ cells, are found (Figs 6 and 7)

A Six-day-old Embryo having Received a Lethal Dose—This specimen was alive when the shell was opened but presented marked malformations, it was more like a lump of rarified tissue than a chick embryo In sections, some organs, such as the neural tube, mesonephros, and the gonads, could be readily identified (Fig 8) In the gonads, undoubtedly the testes, the germinal epithelium, and the testis cords can be recognized, but the tissues are far from being normal In both places the cells are few and far apart (Fig 9) However, unmistakable germ cells occur in both germinal epithelium and testis cords Among these are fully formed germ cells as well as the transition stages (Fig 10)

DISCUSSION

From former work (2), it is known that, with the present set-up of the x-ray machine and age of the material, 600 r is lethal to about 96 per cent of all chick embryos irradiated Most of these die a few hours after exposure to x-rays, but some will survive for several days, and a few will hatch with or without apparent deformities The factors involved in the production of this wide variation in results must, for the present, be explained only on general principles The quality and quantity of the x-rays is not without variation no matter how accurately the machine is set (Packard, 6) This, however, appears to be of minor importance because the eggs were irradiated in triplets and, as a rule, the development of each was different It is clear that hereditary and environmental factors prior to laying play the major rôle

The principle of Bergome and Tribondeau that the more embryonal or undifferentiated the type of cell, the greater is its radiosensitivity, is well established The chick embryos were irradiated when the primordial germ cells were splitting off from the germ wall entoderm and undergoing their early differentiation They were cytogenetically younger and less differentiated than those of the primitive ectoderm, entoderm, and mesoderm, and, therefore, should have been destroyed first This indeed must have happened for none could be identified in the x-rayed chick embryos It is thought significant that definitive germ cells occur in specimens irradiated with lethal doses

Germ cells were present in all irradiated embryos of six days' incubation, they may be found in younger embryos but only in a few specimens and then in not very large numbers This may be due to the fact that in the early stages the x-rayed embryos lag behind the normals in development The germinal epithelium is well advanced in a three-day chick embryo and when intermediate cell stages are abundant These facts lend support to the contention that the cells of the germinal crescent have

X-RAY DIFFRACTION STUDIES OF GLOBULAR PROTEINS

III THE ACTION OF FORMALDEHYDE ON PROTEINS

By GEORGE L. CLARK and JOHN H. SHENK, *Urbana, Illinois*

Chemistry Department, University of Illinois

IT HAS long been known that formaldehyde produces very marked changes in the properties of proteins, principally that of hardening, but no explanation has been found as to the nature of the reaction. Of course, one would expect formaldehyde to attack first the free amino groups, and if further reaction takes place, it would have to attack the amide linkage, probably bridging across from one protein chain to another. This would tie the chains very tightly together and would account for the relatively large increase in weight when proteins are treated with formaldehyde, and also would probably make the protein harder.

When dry gelatin was treated with formalin, it became very gelatinous. When this was left to dry in air, it became quite tough and finally dried quite hard. Dry gelatin gives an x-ray diffraction pattern which is very similar to that of air-dried egg albumin, but after treating with formaldehyde the pattern has been greatly changed, as shown in Figure 1. About five hours are required to obtain a fair pattern of the air-dried protein, while the principal spacing shown in the formaldehyde-treated protein will appear in one-half hour. The outstanding thing about this pattern is the strong ring representing an interplanar spacing of 3.9 \AA .

The fact that the 3.9 \AA spacing gives such a strong interference shows that the treatment of a protein with formaldehyde causes a much more regular alignment of the polypeptide chains. The spacings in \AA appearing on this pattern are as follows: 12.5 w , 6.67 w , 4.79 w , 3.9 m , β , 3.9 vs , 2.61 vw , β , 2.79 w and 2.6 bs . The two strong interferences at 3.9 and 2.6

appear on the diffraction patterns of all of the proteins attacked by formaldehyde, such as egg albumin and hemoglobin. The fibrous proteins—hair, silk, tendon, and feathers—when soaked in formaldehyde give exactly the same diffraction patterns as before treatment, but if they are first swollen and then treated with formaldehyde while in that condition, they give the same strong rings as gelatin, although these may be fibered.

Zein, a prolamine, is insoluble in water and is not strongly attacked by formaldehyde as can be seen in Figure 3, although the 3.9 ring does appear. The two protein rings also show very plainly. The zein is more readily attacked if it is swollen in 50 per cent alcohol before treating with formalin. Swelling with 50 per cent alcohol and then drying does not change the pattern of the protein (Fig. 2), but the treatment of the swollen zein with formalin increases the intensity of the 3.9 \AA ring and also brings out the 2.6 \AA ring which is not visible in the pattern obtained by treating dry zein with formalin (Fig. 4).

In the study of the action of formaldehyde on fibrous proteins, the following substances were used: hair, silk, feathers, and tendon. All were extracted with ether to remove lipid substances which would prevent the penetration of the formalin solution. The specimen-to-film distance was 5 cm for tendon and feathers, and 3 cm for hair and silk. The x-rays used were from a copper target and were filtered through nickel foil. In every case, the x-ray beam was transmitted perpendicularly to the fiber axis. Treatment of the dry fibers with formalin does not change the x-ray pattern.

Dry, ether-extracted tendon swells very readily in both 0.1 N and N potassium hy-

¹ Intensities are indicated by w, weak; m, medium; vs, very strong; vw, very weak; s, strong.

tion in size, the gonads of six-day-old embryos irradiated with a non-lethal dose appear to be normal. The germinal epithelium is developed, fully formed germ cells as well as the intermediate stages are abundant.

(6) In a six-day-old embryo, having received a lethal dose, marked cellular destruction has occurred in all organs, including the gonads, yet unmistakable germ cells are present.

(7) The migratory entodermal cells or primordial germ cells of other authors have not been identified in irradiated material.

(8) The present material supports the conception that the cells of the germinal crescent have no direct relation to the formation of the definitive germ cells in the chick embryo.

(9) The origin of definitive germ cells from the peritoneal epithelium is supported.

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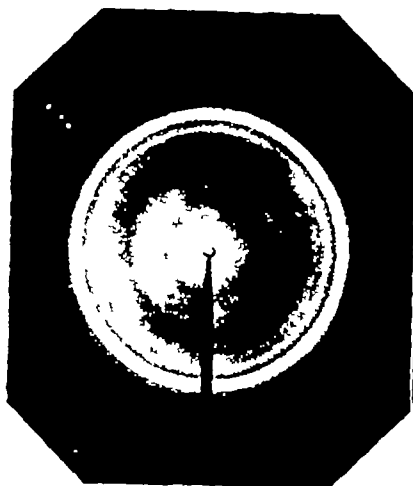


Fig 1



Fig 2

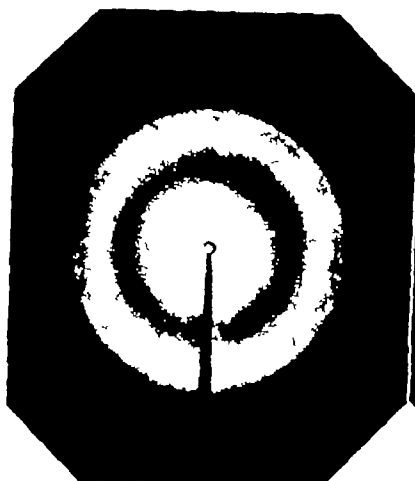


Fig 3

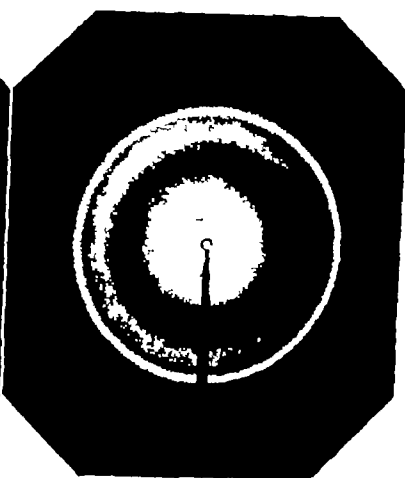


Fig 4

Fig 1 Gelatin treated with formaldehyde

Fig 2 Zein + 50 per cent alcohol air dried

Fig 3 Dry zein + formaldehyde

Fig 4 Zein + 50 per cent alcohol + formaldehyde

dioxide, however, prolonged treatment in N KOH causes disintegration of the fiber. A fiber was swollen in 0.1 N KOH and divided into two portions, one of which was removed from the solution and air-dried while the other portion was placed in formalin for several hours and then air-dried, both under slight tension. Diffraction patterns of the untreated and the two treated samples are shown in Figures 5-7. The untreated tendon gives a well oriented pattern which shows some long spacings. Swelling has little effect, excepting the disappearance of the long spacings, and these would appear if dried under sufficient

tension. Although formalin has no effect upon the dry fiber, it readily attacks the swollen tendon, causing the appearance of the 3.9 and 2.6 Å spacings so outstanding on the formalin-treated gelatin pattern. Fiberings are still evident and the fiberings of these two spacings is 90 degrees apart.

Feather quills were similarly treated. The original fiber pattern is not changed much by swelling in sodium hydroxide solution and then drying. Formaldehyde again brought out these two strong rings fibered perpendicularly to each other, although most of the fiber pattern of the original feather still appears. The feather swelled rather

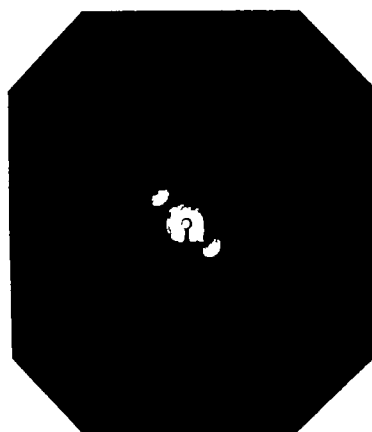


Fig 5

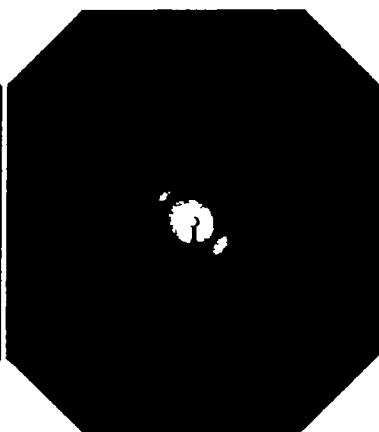


Fig 6

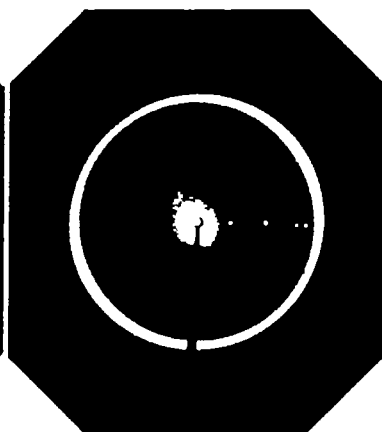


Fig 7

Fig 5 Tendon, not treated

Fig 6 Tendon + 0.1 N KOH air-dried

Fig 7 Tendon + 0.1 N KOH + formaldehyde



Fig 8



Fig 9



Fig 10

Fig 8 Feather untreated

Fig 9 Feather + NaOH

Fig 10 Feather + NaOH + formaldehyde

rapidly in N KOH, but soon lost much of its tensile strength and when treated with formalin the diffraction pattern showed practically no fibering. The feather patterns are shown in Figures 8-10. Although hair does not swell much in the alkaline solution used, it gives the same diffraction rings when treated with formalin. A pattern of untreated hair is shown with the formalin-treated swollen hair in Figures 11 and 12. The two main rings again show fibering at 90 degrees.

Silk does not swell readily in acid or alkaline solutions and, therefore, one would not expect formaldehyde to have much action on it. This is found to be the case

as shown in Figures 13 and 14. The only difference noted in the two patterns is a slightly better oriented pattern than shown by the treated sample.

An examination of the gelatin pattern would lead one to believe that the two strong rings are second and third orders of a 7.8 \AA spacing, but when one compares the gelatin pattern with that of formalin-treated fiber, it is at once evident that these two rings are produced by two entirely different spacings because they are fibered perpendicularly to each other. If they were produced by the same spacing, they would be fibered in the same direction. The amino acid residue length in natu-

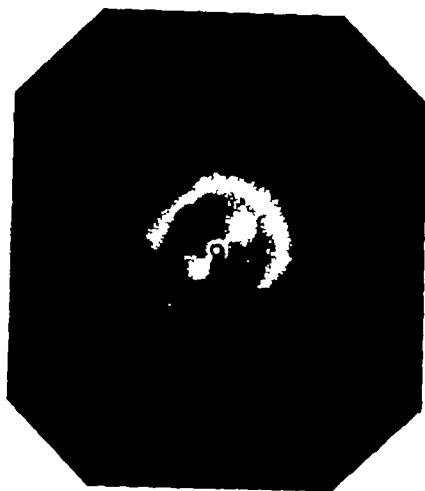


Fig 11



Fig 12

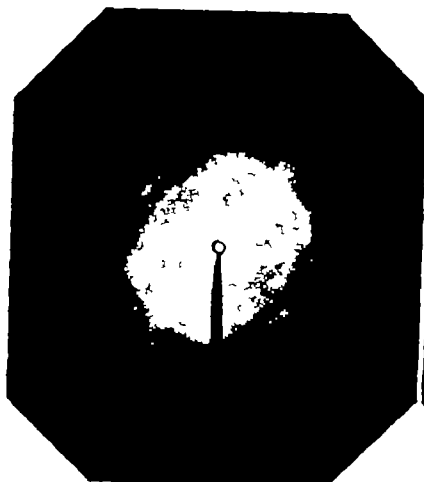


Fig 13

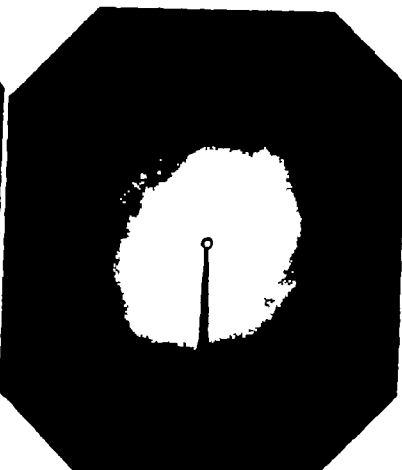


Fig 14

Fig 11 Normal hair untreated

Fig 12 Hair + N NaOH + formaldehyde

Fig 13 Silk

Fig 14 Silk + N KOH + formaldehyde

rally occurring silk and the keratins is about 3.5 \AA , the distance from one nitrogen atom in the polypeptide chain to another. If formaldehyde reacts with the amide nitrogens of two neighboring chains, we should expect a strong ring spacing at 3.5 \AA . Since a strong ring is found at 3.9 \AA , the reaction of the protein with formaldehyde causes a lengthening of 0.4 \AA per amino acid of the chain. The 2.6 \AA spacing is probably the second order of an increased "backbone" spacing due to the reaction. The 12.5 \AA ring represents the silver absorption edge due to

the 3.9 \AA spacing and the 6.67 ring represents the bromine absorption edge.

Swelling of the fibers pushes the protein grids farther apart, thereby facilitating the penetration of the formaldehyde solution so that it could react—and may also cause a certain amount of hydrolysis, which was undoubtedly the case when N KOH solution was used for swelling tendon and feather fibers. Silk fibroin alone is unaffected by formaldehyde, of all the proteins, it alone has hydrogen atoms as the R groups on the polypeptide chains.

It seems logical to assume that the reaction of formaldehyde on proteins takes place at the amide nitrogen because all of the proteins except silk show similar diffraction effects when treated with formalin. Because of the extreme intensity of the 3.9 \AA U ring, there has to be a very definite alignment of a great number of atoms or chains which could only be due to the placing of a large number of atoms close together at regular intervals. Also, since all of the proteins give the same rings in the same positions with the same relative intensities, the reaction is very closely connected with the fundamental structure of the molecule.

SUMMARY

1 Proteins such as gelatin, egg albumin, and hemoglobin after treatment with formaldehyde give diffraction patterns containing two strong rings, neither of which appears in the pattern of the original pro-

tein, and both are very much stronger than the original pattern.

2 Dry zein is not greatly affected by formaldehyde but if swollen in 50 per cent alcohol, it is more readily attacked as shown by the intensity of the rings on the diffraction patterns.

3 Fibered proteins as hair, tendon, and feather quills are not attacked enough by formaldehyde to change the diffraction pattern, but if swollen in an alkaline solution and then treated with formaldehyde, the diffraction pattern resembles that of the formalin-treated gelatin except that fibering still appears and the strong rings are fibered 90 degrees apart. There is no effect on silk fibroin.

4 It is believed that the formaldehyde reaction takes place on the amide nitrogens, tying two adjacent chains together.

5 The 3.9 \AA U spacing is probably due to the slightly extended amino acid residue and the 2.6 \AA U spacing is probably the second order of an increased "backbone" spacing.

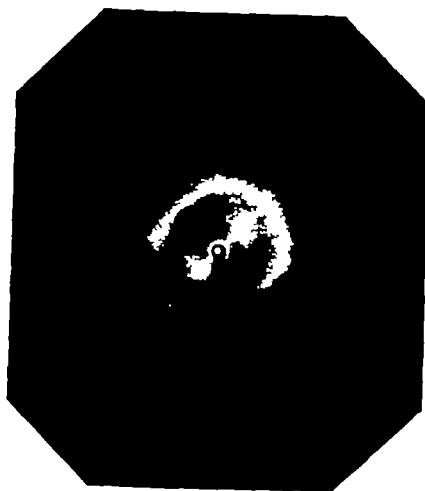


Fig 11

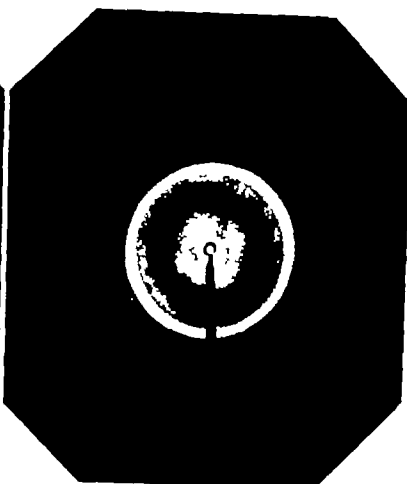


Fig 12

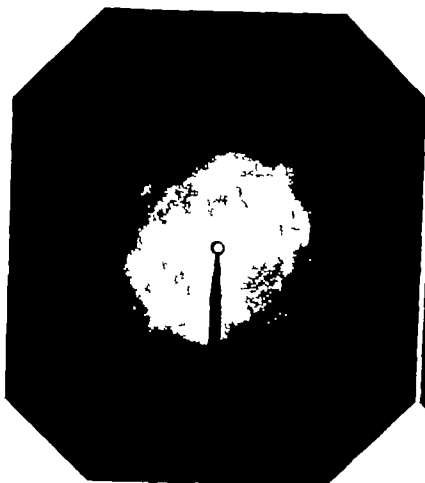


Fig 13

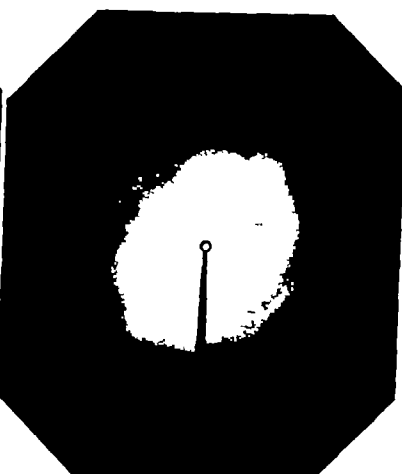


Fig 14

Fig 11 Normal hair untreated
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- (5) Distortion of the normal duodenal swing,
- (6) Pressure defects on the greater curvature of the antrum,
- (7) Air in the bile ducts

In the four cases in which the duodenum was primarily involved (ampullary and primary duodenal carcinomas), the diagnosis was comparatively easy. There were filling defects either in the second or third duodenum, with varying degrees of obstruction, and the normal pattern of the mucous membrane was destroyed. In one case of ampullary carcinoma the lesion was first suspected when air in the bile ducts was visualized on the films of a Graham test. The subsequent examination of the duodenum revealed a fistulous communication between the duodenum and the biliary tract. We believe that air in the bile ducts is significant and a neoplasm should be suspected.

The carcinomas of the biliary system are more apt to give pressure defects with or without obstruction to the duodenum, but they do not produce disturbances in the mucosal pattern. The defect is usually noted in the bulb or at the beginning of the second duodenum. It is not uncommon to find gallstones in carcinomas of the gall bladder. The lymphoblastomas found in the regional nodes at the head of the pancreas also produce defects, particularly at



Fig 3 Carcinoma of the head of the pancreas. Note pressure defect on the greater curvature of the pyloric antrum and constant defect of the second duodenum, together with a fistulous tract.

the pyloric antrum. They may cause duodenal obstruction, but as a rule do not destroy the mucosal pattern unless the walls of the duodenum have been invaded.

In the carcinomas at the head of the pancreas no one finding was constant. They showed signs of obstruction, pressure defects, destruction of the mucosal pattern,



Fig 4

Fig 4 Carcinoma of the ampulla of Vater.



Fig 5

Fig 5 Primary carcinoma of the duodenum. Obstruction of the second duodenum and destruction of the mucosal pattern of the third duodenum.

Note filling defect and narrowing of the second duodenum. Obstruction of the second duodenum and destruction of the mucosal pattern of the third duodenum.

NEOPLASMS INVOLVING THE DUODENUM¹

By SYDNEY WEINTRAUB, M D , and ALLAN TUGGLE, M D , New York City

From the Department of Radiology, Cornell-New York Hospital Association

NEOPLASMS occurring in the region of the duodenum, *i e* , those arising either in the gall bladder, bile ducts, head of the pancreas, or the duodenum itself, present unusual difficulties in diagnosis, not only to the clinician, but also to the roentgenologist. Although the patient may have a well advanced carcinoma in this region the x-ray evidence of a lesion may be easily overlooked unless a minute study of the pattern and contour of the entire duodenum is made. In this study 20 cases have been reviewed, in all of which the diagnosis has been confirmed either by operation, autopsy, or biopsy. The lesions proved to be as follows:

Carcinomas of the head of the pancreas	8
Lymphoblastomas (lymphosarcoma or Hodgkin's of the regional lymph nodes)	4
Carcinomas of the gall bladder and bile ducts	3
Carcinomas of the ampulla of Vater	2
Primary carcinomas of the duodenum	2
Leiomyosarcoma of the pancreas	1

There was definite x-ray evidence of a lesion in 18 of these cases. Of the two cases in which the radiologic examination was reported as negative, one proved to be a tumor 2.5 cm in diameter involving the duct of Wirsung, concerning which the pathologist reported as follows: "The stomach and duodenum were opened *in situ* and the mucous membrane was intact." In the other case an angulation of the second portion of the duodenum suggesting adhesions was reported, but the autopsy revealed a carcinoma at the head of the pancreas involving the gall bladder and regional lymph nodes. The pathologist, however, was not able to identify the primary site of the tumor.

In the 18 cases in which there was definite x-ray evidence of an abnormality, it manifested itself by one or several of the following signs:

- (1) Obstruction of some portion of the duodenum,
- (2) Filling defect of the duodenum,

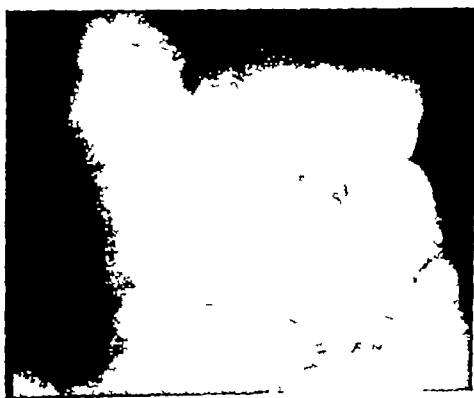


Fig 1

Fig 1 Carcinoma of the gall bladder. Constant pressure defect on the upper portion of the second duodenum.

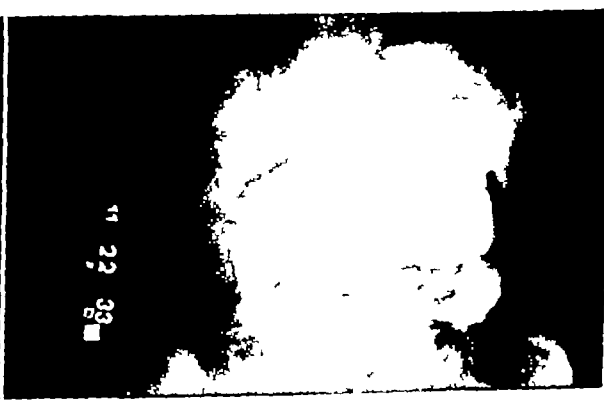


Fig 2

Fig 2 Lymphoblastoma of the pre-pancreatic glands. Marked obstruction of the third duodenum with involvement of the proximal jejunum.

¹ Presented before the Radiological Society of North America at the Twenty-second Annual Meeting at Cincinnati Nov 30-Dec 4, 1936

- (3) Disturbance of the mucosal pattern,
- (4) Pressure defects of the bulb,

genologically but was determined by microscopic studies after operation

A few years ago in a symposium on peptic ulcer on a State Medical Society program, in presenting the roentgenologic phase of the subject I showed slides of this case. In the informal discussion which followed, the Professor of Medicine in a medical school expressed his surprise, stating that he was not aware that primary malignancy of the duodenum had ever been recognized. A search of the literature at that time revealed only a few cases, even from the large clinics, but more recently other reports have been added.

All of us have encountered cases arising in the ampulla of Vater, the head of the pancreas, the liver, and bile ducts. Several such cases have come under my observation, though the records at this time are not available.

The roentgenologic diagnosis of these cases is difficult because there is often such complete obstruction or so little mucosal change that the evidence is not characteristic. Even the pathologist, as has been stated by the author, is often unable to trace accurately the origin of a disease in the mass of malignant tissue.

The authors of the paper just read are to be congratulated on finding diagnostic x-ray evidence of the lesion in such a high percentage of their cases. This paper and other literature contain reports of malignancies of both carcinoma and sarcoma type, but the same difficulties in roentgenologic recognition are encountered with both lesions, since the evidence is confined to the mucosal and luminal changes, together with resulting functional disturbances.

Theoretically, at least, one would give preference to carcinoma when mucosal changes predominate. Pressure defects of the duodenum or antrum of the stomach, or a distortion of the normal duodenal swing would appear to be rather remote evidence upon which to base a diagnosis of this condition, since these may occur in tumors arising in so many neighboring structures.

It would appear, therefore, that the principal evidence would depend upon the authors' signs 1, 2, and 3, namely, obstruction of some portion of the duodenum, filling defect of the duodenum, and disturbances of the mucosal pattern.

This discussion will doubtless serve to stimulate interest in this field and may result in the conclusion that the condition is more frequently encountered than has heretofore been believed.

Careful evaluation of the authors' signs may also help us in differentiating the benign from the malignant neoplasms in this region.

DR. AUGUSTUS W. CRANE (Kalamazoo, Mich.) I was interested in what Dr. Wilson said—that primary carcinoma of the duodenum is exceedingly rare. During my lifetime I have seen one case. That was located in the second ascending limb of the duodenum.

The part which interested me particularly in that case was the behavior of the stomach in the presence of a carcinoma of the duodenum, and to be compared with the behavior of the stomach was an ulcer in the same locality. It happened that at the time of this carcinoma of the duodenum, we had also an ulcer of the duodenum in the same locality. Both were operated upon and the nature of the trouble was undoubted.

In the case of the carcinoma of the duodenum, the only evidence we had of some involvement of the bowel, of the intestine, was the fact that there was a 48-hour retention of the stomach contents without an obstruction of any kind to be demonstrated. At times we imagined we saw an antiperistalsis but at least there was no obstruction shown at operation and yet there was this massive gastric residue.

I offer this as one of the signs of an involvement of the intestine which may not otherwise be identified.

This case of carcinoma of the duodenum was operated upon at the Mayo Clinic finally and no obstruction was found. It was a "napkin ring carcinoma" of the duo-

distortion of the duodenal loop, or a combination of these findings. In cases in which the tumor is so small or so located that it does not impinge upon the surrounding structures, the diagnosis cannot be made radiographically. The normal swing of the duodenum was distorted in some of our cases but in not one of them was it uniformly widened, as one is apt to see in cysts of the pancreas. The leiomyosarcoma of the pancreas showed a crater in the second duodenum. This was called an ulcer in another institution one year after our original diagnosis of carcinoma. We have seen several such cases in which the lesion simulated an ulcer of the second duodenum, but the patient eventually succumbed to a neoplasm. It may be of some significance to note that six out of the eight carcinomas of the head of the pancreas showed a lumbar scoliosis away from the affected side. In the other types of lesions this sign was not constant.

A brief résumé of the clinical data shows that there were 12 females and 8 males. The symptoms were usually of short duration and 14 patients were complaining for only three months or less. The loss of weight and strength was rapid, and when there was obstruction to the duodenum these symptoms became very marked because of the persistent vomiting. Jaundice was present in 12 cases and a mass was palpable in 8. Out of 15 cases in which the stool was examined for blood, 9 showed a positive benzidine reaction.

We are also impressed by the fact that the radiologist can be of help in more definitely localizing some of these lesions. Many of these become quite extensive and involve most of the structures in the right upper quadrant. On the operating table, at times, it is difficult to determine the primary site of the tumor and even the pathologist may be uncertain. In some of our cases the lesion was reported to be situated at the ampulla of Vater, but the radiographs presented a normal second duodenum and a filling defect in the third portion. The ampulla of Vater, according to the anatomist, enters the duodenum at the

upper third of the second portion, 7.5 to 10 cm from the pylorus. Unless the duodenum is incised, one cannot be certain that the carcinoma is ampullary, and we believe that some of these are really primary carcinomas of the duodenum.

CONCLUSIONS

The x-ray diagnosis of neoplasms in the region of the pancreas, biliary system, and duodenum is difficult.

Out of the 20 cases studied, 18 showed x-ray evidence of a lesion.

A minute study of the contour and mucosal pattern of the entire duodenum should be a part of the routine procedure in every gastro-intestinal series.

DISCUSSION

DR. RABUN T. WILSON (Austin, Texas): The rarity of a disease serves to intensify our interest in its investigation. Often a study leads to the discovery that it occurs more frequently than has heretofore been believed. While this is true with the particular subject in hand, it nevertheless remains a comparatively rare condition and one of unusual interest.

Lesions in the duodenum are quite common, occurring in approximately 10 per cent of gastro-intestinal studies and constituting 80 per cent of organic lesions in the gastro-intestinal tract, but all of these, in my own experience, with one exception, have been of the benign ulcerative type.

A malignant growth from the stomach or other neighboring structures, invading the duodenum by extension, is a common finding but a primary ulcerative lesion in the duodenum is rare.

My experience is confined to the one case out of approximately 25,000 gastro-intestinal studies. This lesion occurred in a man 55 years of age, was located near the apex of the bulb or first portion of the duodenum, and was producing well-marked luminal reduction and a well-defined mucosal irregularity with almost complete obstruction resulting. Its malignant nature was not recognized roent-

VANISHING LUNGS A CASE REPORT OF BULLOUS EMPHYSEMA

By RICHARD M. BURKE, M.D., Veterans' Hospital, Sulphur, Oklahoma

BULLOUS emphysema is usually associated with strictures of the bronchi. These narrowed bronchi permit the inspired air to enter the alveoli, but on expiration the outlet closes and back-pressure is created, a mechanism which in time causes dilatation, atrophy, and rupture of the alveoli. Finally, large emphysematous bullae evolve from the coalescing alveoli. The histopathology of blebs and bullae has been described by W. S. Miller (1, 2).

The etiology of the obstruction in bullous emphysema is frequently obscure. Presumably in some instances the bronchial changes are the result of developmental errors, in others, pulmonary fibrosis of unknown etiology such as described by Hampton (3) may be the cause. The best understood type is that in which bullae follow localized productive changes such as result from tuberculosis. Haymaker and Karan (4), and Freedman (5) have reported examples of the latter type.

The diagnosis, made largely from the x-ray examination, may be confused with partial pneumothorax, cystic disease, and tuberculous cavitation. The x-ray appearance has been discussed by Haahti (6), Vadone and Maissa (7), Freedman (5), and others.

The following, I believe, is one of the most advanced cases of bullous emphysema recorded.

CASE REPORT

In 1929, I. J. S., 28 years of age, was forced to quit work. His complaints then were general weakness and increasing shortness of breath. A diagnosis of tachycardia of unknown etiology, and chronic bronchitis was made by the Veterans Bureau. According to the history, he had spent four years in the Army where his duties had been light. After his discharge in 1923, he worked as a day laborer, spending several years as an oil field worker.

In 1930 he entered the Veterans Hospital, and a diagnosis of bilateral pneumothorax, of unknown etiology, was recorded. Following this, he visited several other hospitals and also returned here on three occasions. His medical file reveals that he was somewhat of a diagnostic problem wherever he went. One diagnosis given was congenital atelectasis of both upper lobes. However, this case was discussed and correctly diagnosed in a paper by Korol and Ensign (8) in 1934.

His last admission here was on Oct. 4, 1935, at which time he was quite dyspneic, weak, and moderately emaciated. The patient's past history was negative except for typhoid fever in 1913. Also he related that as a child he tended to tire rather easily.

Physical examination was essentially negative except for the chest. Blood pressure 108/96. Rate rapid with tones weak in character. Chest was of the emphysematous type. Hyper-resonant on both sides. Breath sounds absent except over the bases. Whispered voice practically absent. Coin test negative. No suggestion of amphoric quality to breath sounds. Diagnostic pneumothorax gave neutral readings on both sides.

The patient's chest films, taken at intervals during past six years, were reviewed. They revealed a progressive bilateral downward loss of lung markings. Stereoscopic views showed fine web-like markings extending upward from the areas of normal appearing lung.

Figures 1 to 6 illustrate how the lungs seemed to vanish. A film taken on July 28, 1930 shows the pulmonary markings absent down to the third rib on the right and the fourth rib on the left (Fig. 1). A postmortem film (Fig. 6) shows absent markings to the fifth rib on the right and to the eighth rib on the left.

In 1935 a circumscribed mass was first

denum, and the patient finally died from a metastatic involvement of the other organs. The postmortem revealed the true situation.

Dr. Charles Mayo wrote me a very full letter about it, and the fact of the absence of an obstruction is what I want to impress upon you—that you can have massive gastric residue in those cases with absolutely no obstruction.

As a comparison with what happens in the case of ulcer of the duodenum, you have exactly the same reaction of the stomach as when the ulcer is located in the bulb of the duodenum—that is, a rapid peristalsis with rapid gastric emptying. The expulsion of gastric contents goes on so rapidly that you would naturally suspect that you had the familiar lesion in the duodenal bulb.

I might say also, in regard to the rarity of these lesions, that at this time Dr. Car-

man was living. He had also examined this same patient after the latter had been sent to the Clinic for operation. He told me, as I recall, that in some 30,000 cases of cancer at the Mayo Clinic they had had only four cases of primary carcinoma of the duodenum.

DR. TUGGLE (closing). It is our plea that in patients suspected of having carcinoma in the right upper quadrant, a very minute study of the entire duodenum be made. You will be surprised if you will go back over your old films of proven cases of carcinoma in this region and note the smaller changes in the mucosal pattern that you will find.

Primary carcinoma of the duodenum is rare. Out of our cases there were four—that is, two ampullary and two primary duodenal.

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Fig 5

Fig 5 Lung tissue continues to fade Mass in left hilus increases in size (Feb 19, 1936)

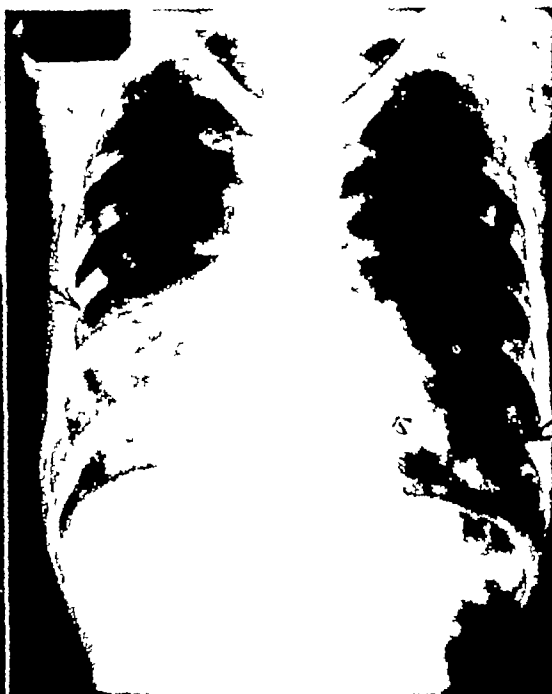


Fig 6

Fig 6 Postmortem film Mediastinal shift to the right is seen Practically no lung tissue visualized on the left while about half of the right lung remains (April 4 1936)

noted in the left hilus region (Fig 4) This slowly increased in size until death

The patient was subject to acute attacks of dyspnea, suggesting a cardiac asthma rather than a typical bronchial asthma. His respirations would become rapid and shallow during an attack, and he often would request the windows to be opened. He complained of tightness in the chest. These attacks started in 1932 and were at first partially relieved by ephedrine and adrenalin. Later they became more severe and nothing short of morphine would relieve him. During the last few months the attacks occurred five or six times a week and usually lasted from 30 to 60 minutes. Between attacks he was relatively comfortable, even up to the time of his death.

He became more emaciated, developed an exhaustion psychosis and died on April 5, 1936.

An autopsy was done. Upon opening the chest, the lungs ballooned out and overfilled the chest cavity as though under pressure. This was especially pronounced on

the left (Fig 7). The upper lobes remained distended even after considerable manipulation. Both lungs had a lobulated appearance with many blebs seen.

The right upper lobe contained one large bulla plus a number of lesser emphysematous bullae and blebs about its lower margin. No gross communication between the various bullae could be demonstrated.



Fig 7 View of chest upon removing ribs Shows over distended appearance of upper lobes. On opening these lobes practically empty pleural sacs were revealed.



Fig 1

Fig 2

Fig 1 Bilateral bullous emphysema. More pronounced on the left. Lung markings absent down to the levels indicated by the arrows (July 28 1930)

Fig 2 Appearance seven months later (Feb 23 1931)

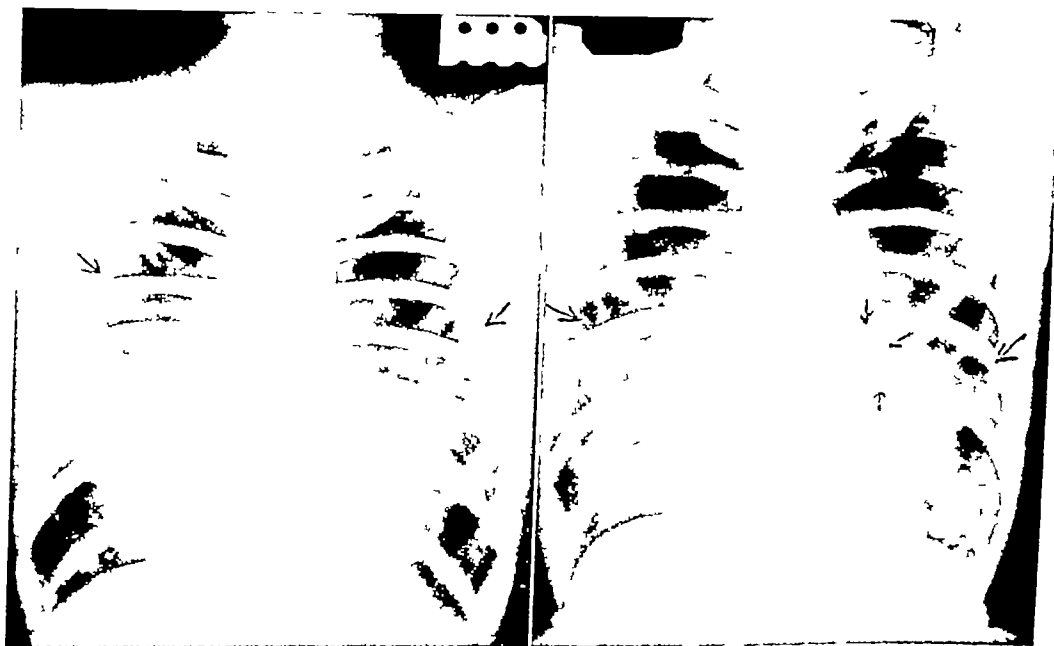


Fig 3

Fig 4

Fig 3 The downward recession of lung markings continues (Nov 7 1932)

Fig 4 Circumscribed mass appears in left hilus region (Oct 4 1935)

A large bulla can simulate a tuberculous cavity. We have seen one case and Miller (9) has described such a case. A differential point in such instances is mentioned by Freedman (5), who states that a number of curved shadows around the area of diminished density should arouse one's suspicions that they represent something else besides cavitation.

Cystic disease of the lung usually presents circumscribed areas of increased brilliancy. Fluid levels are not uncommon. The walls of the cyst are well defined in contrast to the delicate filmy margins of bullae and blebs.

Lipiodol will often visualize the stenosed or occluded bronchi. Serial films showing the progress of the emphysema are pathognomic. Films taken in the knee-chest position have been recommended, a procedure which is said to cause congestion of the blood vessels in the upper lung-fields and thus enable them to be visualized. In the above case we were unable to note any change following such a procedure. Fluoroscopy will show a slight increase in the size of the bullae on expiration as compared with inspiration. Diagnostic pneumothorax ordinarily should be attempted only when other methods fail.

As far as we know the associated bronchiogenic carcinoma did not play any part in the evolution of the bullae we have described. Swenson (10) and Freedman (5) have reported primary malignancy associated with bullous emphysema.

Treatment—The establishment of outside fistulae and extirpation of the affected areas have been attempted. Removal of air will sometimes give temporary relief.

CONCLUSION

A case of bilateral bullous emphysema with an associated bronchiogenic carcinoma is reported in which two-thirds of the lung tissue had been replaced by giant bullae.

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The upper left lobe was adherent to the chest wall and mediastinum. Practically all that remained of this lobe was an



Fig 8 The giant bulla which occupied most of the left pleural cavity

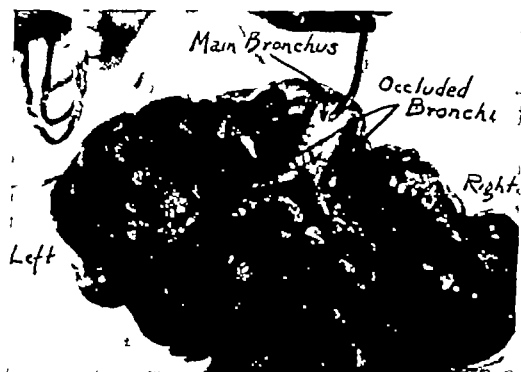


Fig 9 Posterior view of lungs. The occluded upper lobe bronchi are indicated

empty pleural sac (Fig 8). This giant bulla occupied four-fifths of the left chest cavity.

Analysis of gas samples taken from these bullae showed atmospheric air. (It has been suggested that the acute dyspnea in these cases was due to rebreathing air from these

large sacs which were thought to contain a high percentage of CO_2 .)

Section of the compressed lower lobes revealed some increase in fibrosis but no evidence of tuberculosis. A solid tumor, 4 cm in diameter, was found along the left main descending bronchus. Tissue examination showed it to be a bronchiogenic carcinoma, Grade IV.

Dissection of the bronchial tree showed narrowing and occlusion of bronchi going to the upper lobes (Fig 9). Why this narrowing and occlusion had occurred was not apparent. The increase in fibrosis which was present would hardly explain it. No definite openings into the large bullae could be demonstrated. Presumably a communication did exist but was closed off some time prior to death.

The remainder of the autopsy revealed no other significant findings.

DIAGNOSIS

There are a few points in diagnosis which might be recalled. There was little cough or sputum. Unexplained progressive increasing shortness of breath was the most significant symptom, plus periodic spells of dyspnea in the advanced stages. The latter is thought to have been due to pressure on the mediastinum by the distended lungs. Also pulmonary hypertension probably developed, due to the diminishing lung tissue and fibrosis.

Although physical signs suggested pneumothorax, the amphoric quality of the breath sounds sometimes heard in pneumothorax was absent.

On x-ray examination a gradual fading of the lung markings, usually beginning at the apices, was noted, to be differentiated from pneumothorax by the absence of a sharp lung line. Close examination showed fine unanatomical markings in the radiolucent areas, best seen on stereoscopic films, markings which were due to fibrous septa—all that remained of the lung tissue. In pneumothorax the affected area regresses, while in emphysema it progresses. Also, a so-called chronic pneumothorax will invariably lead to fluid formation.

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EDITORIAL

LEON J. MENVILLE, M.D., *Editor*

HOWARD P. DOUB, M.D., *Associate Editor*

GASTROSCOPY AND THE RADIOLOGIST

In this country, the endoscopic examination of the stomach, commonly called gastroscopy, is a relatively new procedure. The numerous contributions of Dr. Rudolph Schindler, one of the pioneers in this field, and his students are, no doubt, largely responsible for the present interest in this method of examination. Such an interest among radiologists was well demonstrated by the attention directed to the Symposium on Gastroscopy and Roentgenology in the Diagnosis of Diseases of the Stomach at the recent meeting of the Radiological Society of North America. The papers in this symposium, which will be published in a forthcoming issue of *RADIOLOGY*, will, unquestionably, be widely read.

Radiologists, particularly, are giving consideration to this diagnostic procedure because of the possible effect upon their practice. Any non-hazardous means, furthering our knowledge of gastric diseases, is welcome. The direct inspection of the mucous membrane of the stomach, which this procedure affords, offers many opportunities for the intimate study of gastric lesions. While not entirely without danger—occasional perforations may occur—examination with the Wolf-Schindler flexible gastroscope is not exceedingly difficult or trying to the patient. The effect which the widespread application of this method may have upon radiological practice lends itself to the following three considerations.

First of all, it should be clearly understood that the gastroscopic examination supplements rather than competes with the roentgen examination of the stomach. An adequate roentgen study is an absolute prerequisite for an intelligent, conservative endoscopic examination. The practice of gastroscopy, in any community, should stimulate an additional interest in diseases of the stomach. Hence, it seems probable that the introduction of

this procedure will increase rather than decrease the number of gastro-intestinal cases referred to the radiologist.

Secondly, gastroscopy creates a new stimulus and a new guide for the activities of the roentgen diagnostician. At one time surgery was the chief factor in the discipline, so necessary to keep us from degenerating into smug complacency. The decline of surgical intervention in non-tumorous lesions of the stomach, together with the realization that inspection and palpation of the exterior of the stomach gives no final assurance of the presence or nature of a lesion have somewhat modified the salutary effects of laparotomy for determining the value of roentgen conclusions. The development of another method of examination should give the radiologist another desirable control for the accuracy of his findings.

Finally, and to the radiologist, most important of all, the endoscopic study of the stomach may prove to be an educational force of considerable importance. The unsatisfactory character of the usual gross and histological investigations of the pathology of gastric diseases is well known. The results, at this date, indicate that longer experience with direct inspection of the gastric mucosa in the living individual will teach us many facts about those diseases, particularly gastritis, which, prior to this time, have been difficult to elucidate. The gastroscopic observation of mucosal erosions, gastric ulcers, and the various types of gastric tumors should prove of great value in establishing anatomical data to guide us in the interpretation of roentgen observations.

Although realizing that it is a supplementary procedure, that it has many sharp limitations and that it is not without danger, the radiologist should welcome and encourage the establishment of intelligent and conservative gastroscopy in his community.

LEO G. RIGLER, M.D.

ANNOUNCEMENTS

EXCEPTIONAL EDUCATIONAL OPPORTUNITIES AT THE FIFTH INTERNATIONAL CONGRESS OF RADIOLOGY

An unusual opportunity will be offered at the Fifth International Congress of Radiology, Sept 13 to 17, 1937, Palmer House, Chicago, Illinois, for instruction in certain selected fields of radiology. The courses to be offered are as follows

ROENTGEN THERAPY IN CANCER

Dr Henri Contard, Chief of Roentgen Therapy Service in the Radium Institute, Paris, France

PROBLEMS IN ROENTGENOLOGICAL DIAGNOSIS

This is an advanced course for experienced radiologists which will deal with difficult problems of diagnosis selected from the vast material available at the Massachusetts General Hospital

Dr George W Holmes, Clinical Professor of Roentgenology, Harvard University Medical School, Director of Radiological Department, Massachusetts General Hospital, Boston, Massachusetts

Dr Holmes will be assisted by his associates, *Dr Aubrey O Hampton*, *Dr Richard Schatzki*, and *Dr Richard Dresser*

THE FUNDAMENTALS OF ROENTGEN AND RADIUM THERAPY

Prof Dr Hermann Holthusen, Professor in the University, Chief of the Radiological Service, St. George Hospital, Hamburg, Germany

ROENTGEN DIAGNOSIS IN GASTRO-ENTEROLOGY

Dr B R Kirklin, Associate Professor of Radiology, University of Minnesota, Graduate School of Medicine, Chief of the Department of Radiology, Mayo Clinic, Rochester, Minnesota

Dr Kirklin will be assisted in this course by other radiologists who are outstanding in this special field

SPECIAL PROBLEMS OF RADIATION THERAPY RELATING PARTICULARLY TO TREATMENT OF CANCER OF THE CERVIX AND CANCER OF THE BREAST

This course is directed especially to the needs of the specialist in radiology and will be found of particular interest to radiologists located in the smaller centers of population

Dr Edwin A Merritt, Clinical Professor

of Radiology, Georgetown University Medical School, Chief Radiologist, Warwick Memorial Clinic and Garfield Memorial Hospital, Washington, D C

THE DIAGNOSIS OF BRAIN LESIONS

Dr Merrill C Sosman, Assistant Professor of Roentgenology, Harvard University Medical School, Chief of Radiological Service, Peter Bent Brigham Hospital, Boston, Massachusetts

ELEMENTARY PHYSICS OF RADIATION

Dr James L Weatherwax, Philadelphia General Hospital, Philadelphia, Pennsylvania

Each of the above courses will occupy four hours, that is, one hour on each day of the Congress, September 14 to 17, inclusive. The courses will be given at an hour when they will not conflict with other activities of the Congress, namely, eight to nine in the morning.

Each of the courses will be given in English and will be open to between fifty and one hundred members of the Congress who will register specifically for any one course. Those who have already made application for membership in the Congress may register for one of the courses by writing to the General Secretary, 2561 N Clark Street, Chicago, Illinois. Applicants for membership in the Congress hereafter may register when they submit their applications. Registrations for the courses will be accepted in the order of their receipt at the Chicago office.

All courses will be given without extra charge to members of the Congress who register for them in the manner indicated above. It is desired that registration be made at as early a date as possible.

NEW APPLICATION FORM

At the order of the Executive Committee of the Radiological Society of North America, a new application form to be used by those applying for membership has been prepared and is now ready for distribution. Please do not use the old blanks which you may have on hand, but secure new blanks from the Secretary-Treasurer, Donald S Childs, M D, 607 Medical Arts Bldg, Syracuse, N Y.

ANNOUNCEMENT OF PRIZE AWARD

A David Anderson-Berry Gold Medal, together with a sum of money amounting to about £100, will be awarded in July, 1938, by the Royal Society of Edinburgh to the person,

who, in the opinion of the Council, has recently produced the best work on the nature of x-rays in their therapeutic effect on human diseases. A similar award will be made every three years.

Applications for this prize are invited. They may be based on both published and unpublished work and should be accompanied by copies of relevant papers.

Applications must be in the hands of the General Secretary, Royal Society of Edinburgh, 22 George Street, Edinburgh 2, by *June 1, 1938*.

AN OPEN LETTER TO RADIOLOGICAL SOCIETIES AND RADIOLOGICAL SECTIONS OF COUNTY AND STATE MEDICAL ASSOCIATIONS

It has been suggested to the Editor that a comprehensive list of such societies would be useful and of interest to the readers of RADIOLOGY, and he is inclined to agree, considering the communications received from time to time from enterprising secretaries. If you belong to such a society, please remind the secretary of it to send information concerning officers and place and time of meeting to RADIOLOGY to be so listed. The Editor can determine from the responses received whether or not there exists a desire for such a listing.

INTERNATIONAL CONFERENCE ON FEVER THERAPY

In conjunction with the International Conference on Fever Therapy to be held at the Waldorf-Astoria Hotel on March 29, 30, and 31, 1937, there will be a scientific and commercial exhibit.

The clinics will be held at the College of Physicians and Surgeons, Columbia University, New York City.

A large attendance of fever therapists from all over the world is expected. A very interesting and instructive program has been arranged and all of those who plan to attend the conference are urged to register promptly with the General Secretary, Dr. William Bierman, 471 Park Avenue, New York City. The registration fee is \$15.00.

IN MEMORIAM

The Radiological Society of North America has lost by death two valued members, Dr. Augustus W. Crane and Dr. Thomas O. Menees. In the next issue of RADIOLOGY it is hoped to publish sketches of our late confreres.

BOOK REVIEWS

"RÖNTGENKYMGRAPHISCHE BEWEGUNG LEHRE INNERER ORGANE" (Roentgen Kymographic Dynamics of the Internal Organs). By VON DR. PLEIKART STUMPF, DR. H. H. WEBER, DR. G. A. WELTZ, VON DR. W. BOHME (Rostock), DR. M. DAHM (Köln), DR. TH. C. NEBEFF (Würzburg), DR. G. M. SACK (München-Gladbach), DR. E. SCHOEN (München), DR. G. VON DER WETH (Berlin). A volume of 516 pages, 417 illustrations and explanatory colored plate. Georg Thieme, Leipzig, 1936. Price, 44 RM.

If roentgen kymography becomes an accepted practical method for the examination of the movable organs of the body, this volume will survive as one of the classics of roentgen literature. In any event it will always be a valuable source book for information about the theory and practice of kymography.

Abundantly illustrated, well printed, thoroughly indexed in the table of contents, with a fairly complete bibliography, this book presents the work of Pleikart Stumpf, the pioneer in roentgen kymography, and that of many collaborators covering the entire field of work which the method embraces. Briefly, kymography is a graphic method of portrayed motion. As such, it is applicable to many organs and its usefulness in the study of the heart, pericardium and great vessels, the lungs, diaphragms and thoracic cage, the thyroid gland, the esophagus, stomach and duodenum, and the upper urinary tract are well portrayed.

The technical procedures, the development of the apparatus, the theoretical considerations in the various types of kymography are discussed in great detail. Methods for transforming the shadows shown on the film, made with the kymograph, into more obvious curves are clearly demonstrated. The theory and practice of kymoscopy are also presented in detail. Of considerable interest is the miniature grid which comes with the book. By superimposing this upon many of the outline drawings of kymograms or even upon some of the reproductions of the films the effect of a kymoscope may be obtained. In this way the true nature of the kymogram may be demonstrated, that is, the reversal of the process by which the film was produced will demonstrate the normal movement of the organ examined.

As might be expected, the heart and great vessels receive the major attention. The normal movements are recorded in great detail with thorough discussion of the physiology thus revealed. Considerable experimental work with the kymograph on both animals and man has been done to illuminate many of the problems concerned with the normal and pathologic physiology of the heart. Abnormalities are dealt with most completely.

Among the most interesting chapters is that dealing with the peristaltic waves of the stomach which can be strikingly portrayed by this method.

Altogether, this book is a mine of information on a subject of great importance in the future of roentgenology. To anyone wishing to become familiar with the kymographic method, the volume is invaluable.

WHO'S WHO IN INDUSTRIAL MEDICINE AND TRAUMATIC SURGERY. A. D. CLOUD, Editor. A volume of 289 pages, bound in half leather. Published by Cloud Publishing Company, Chicago, 1936. Price, \$9.00.

Industrial medicine has become a specialty in medical practice because of the need and recognition of physicians who will make a study of the conditions around the relations of patients to their employment in industrial life. The study of how best to handle the health and well-being of employees in industry and how to correlate the risks, injuries, diseases, and treatment of same to the best advantage of employer and employee are the *raison d'être* for industrial medicine.

The editor of this book wanted to dignify the field, by letting it be known that there are some, at least, of the more important medical men engaged directly in this field. Among these he recognized many who have done outstanding preventative and curative work. He wanted to publish a book that would, by its own appearance and form, put an end to the abortive directories, where every name in them were paid for by the men named. In this book, *not one of the men whose names are listed, paid a cent for such publication.* It is not that kind of a book. He wanted to make available, for ready reference in libraries, offices, editorial sanctums, etc., information relative to the principal men who are writing on medical subjects, with particular reference to industrial

medicine, traumatic surgery, occupational diseases, and allied subjects. He wanted to give a collection of biographical data in the field of industrial medicine and traumatic surgery, which would be in every respect comparable to "Who's Who in America" and evidently he has succeeded in doing exactly that.

The names are arranged alphabetically and geographically (in a supplementary list).

The format, paper, printing, etc., are good. The book will prove to be valuable in many places.

RÖNTGENDIAGNOSTIK DER KNOCHEN- UND GLENK KRANKHEITEN. PART III—JOINT OSTEOMATOSIS AND CHONDROMATOSIS. By VON PROF. DR. ROBERT KIENBOCK. A volume of 228 pages, 194 illustrations. Published by Urban & Schwarzenberg, Vienna, 1934. Price, RM 22.50.

The author presents us with a review of the joint osteomas and chondromatosis. It is prepared in the form of an atlas of radiology with a review of the pertinent facts regarding the diagnosis of these conditions. The author presents a complete review of the important literature on each of the phases of the subject and numerous case histories of each type with excellent roentgenographic pictures.

The work is divided into three parts. Part I, joint osteomatosis (which he designates as a "new disease of joints"), Part II, joint chondromatosis (benign), and Part III, malignant chondromatosis and chondrosarcomatosis of joints.

The latter two subjects are ably presented, excellently illustrated and, the writer thinks, cover the present knowledge of this subject in a most excellent manner. Chondrosarcoma, though rare of the joint capsule, rightly has a place in the discussion. Reviewing the cases presented in the text, we are led to believe that some of these are primary to chondrosarcomas of the bone rather than of the joint capsule with secondary extension into the joint. The differentiation may be and probably is of academic importance and interest.

As for the "new disease of joints," "joint osteomatosis," we fail to be impressed with the importance or *rationale* of such a nomenclature for it simply represents a grouping together of what we have usually called hypertrophic changes typical of the so-called hypertrophic arthritis or osteoarthritis and of trau-

matic arthritis, and a second group of what he calls solitary and atypical changes which are benign osteochondromas involving or extending into the joints. We cannot see where such a classification helps our knowledge of these conditions but, on the other hand, would say that it seems to us to be confusing.

With it, the author presents an excellent group of cases and a complete review of these case histories, giving us therein an atlas of radiographic reviews of these cases which is valuable to anyone seeking information on this subject.

STRAHLUNGEN WESEN, ERZEUGUNG UND
MECHANISMUS DER BIOLOGISCHEN WIRK-

UNG. By DR. KARL G. ZIMMER, Assistant
an der Strahlenabteilung des Cecilienhauses
Berlin-Charlottenburg. A volume of 72
pages, 40 illustrations. Published by Georg
Thieme, Leipzig, 1937. Price, 3.20 RM,
pasteboard.

In this booklet which is one of a series, "Problems der Theoretischen und Angewandten Genetik und deren Grenzgebiete" (W. F. Reing, Editor), Zimmer discusses the whole range of radiations fundamentally, completely, briefly, and yet simply. It is an excellent introduction to radiophysics and it gives to all an understanding of the fundamentals of radiation biology.

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 J E HABBE M D , of Milwaukee, Wisc
 H A JARRE, M D , of Detroit, Mich

ERNST A POHLE, M D , Ph D , of Madison, Wisc
 WILLIAM R STECHER, M D , of Easton, Penna
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FISTULAS

Etiology and Therapy of So-called Fistula Ani
Robert Baumann and Kasper Blond Schweiz med
Wchnschr, April 11, 1936, pp 358-361

Through extensive roentgenographic study of injected fistulae *in ano*, the authors are convinced that anal fistula should be considered as *thrombophlebitis purulenta chronica ani et recti*. Almost without exception, the typical fistula commences as a peri-proctal abscess, which becomes thrombosed and later causes infected varices. It can be dogmatically stated that in a case in which a fistula is present, hemorrhoids are present. After rupture of the fistula externally, gas and feces escape thereby. The important consideration is the fact that the lining of the fistula is composed of endothelium partly from the venous walls and therefore granulation tissue cannot be formed.

WILLIAM R. STECHER, M D

FRACTURES

Fracture of the Neck of the Femur F J Gaenslen
Jour Am Med Assn, July 11, 1936, 107, 105-114

From the story of the clinical course of the impacted fracture one can best understand the underlying principles involved in the healing process.

No one method of reduction will fit all cases, all cases properly reduced and properly spiked will not go on to solid union. Internal fixation has decided advantages over external fixation and present day conventional methods, while representing a distinct advance as compared with earlier methods will give way to more precise and more certain procedures.

The author attempts to rationalize first the method of reduction of fractures of the neck of the femur by traction in flexion and secondly the method of internal fixation. This attempt is based in part on clinical observations and in part on experimental studies on the skeleton and on animals.

CHARLES G SUTHERLAND M B (Tor)

See also under "The Hip Joint," page 382

Duration of Fractures and Operative Defects of the Skull as Revealed by Roentgenograms (A Follow-up Study of 100 Patients) Mark Albert Glaser and Edward S Blaine Jour Am Med Assn, July 4, 1936 107, 21-24

Because of academic and also medico legal interest, 100 cases were studied by repeated roentgenographic examinations with all technical factors standardized as far as possible. In all children studied, linear fractures disappeared within six months from the time of the injury, in adults the time varied to as long as eight years. Depressed fractures show obliteration of the fracture lines in from one to four years. In depressed fractures in which fragments of bone are removed the filling defects did not decrease in size. Loose fragments of bone were gradually absorbed. Operative defects

acted similarly, the bone never fills in and the edges become smooth and rounded. Osteoplastic bone flaps of the skull turned down for tumor or hemorrhage usually do not degenerate. They are united to the skull by heavy bands of fibrous tissue.

CHARLES G SUTHERLAND, M B (Tor)

GALL BLADDER (NORMAL AND PATHOLOGIC)

Cholangiographic Demonstration of Biliary Dys-synergia and Other Obstructive Lesions of the Gall Bladder and Bile Ducts R Russell Best and N Frederick Hicken. Jour Am Med Assn, Nov 14, 1936, 107, 1615-1619

Dyssynergia is defined as a spasm of the lower end of the common duct. This and obstructive lesions of the extra-hepatic bile ducts have been demonstrated during operation by cholangiography, *i.e.*, injecting radiopaque fluids into the common duct. This procedure they termed "immediate cholangiography", the injection of radiopaque substances post-operatively, through catheters, tubes or fistulas, has been designated "delayed cholangiography". Lipiodine, thorium dioxide sol and hippuran were found most suitable, each had its advantages and disadvantages. Immediate cholangiograms proved a definite aid in diagnosis and prevented complicating circumstances which arose from incision and exploration of the common duct. The status of the cystic duct can also be ascertained.

Delayed cholangiograms are an aid in determining the status of the choledochal sphincter, the presence of overlooked stones, stricture and tumor and the presence of pancreatitis or tumor of the pancreas and also help determine when sufficient time has elapsed for biliary drainage.

CHARLES G SUTHERLAND M B (Tor)

Elimination of Confusing Gas Shadows during Cholecystography by the Use of Pitressin E N Collins and J C Root Jour Am Med Assn, July 4, 1936 107, 32

In the course of 800 cholecystographic examinations, the use of this preparation was deemed advisable in 73 instances. They have found the use of pitressin more effective than the use of enemas. In the absence of cardiovascular contra indications the dose is one ampoule (10 pressor units). The preparation has not been used in patients having a systolic blood pressure below 100 mm of mercury or in patients who have advanced hypertension or suspected coronary disease. Cholecystograms were made from 45 to 60 minutes after the injection of the drug. In practically all instances in which the drug was used, intestinal activity was evidenced by mild, cramp like sensations in the abdomen, together with a feeling of expected defecation if this did not actually occur.

In those instances in which the blood pressure was taken every five minutes for one hour there was a gradual and progressive fall in both the systolic and diastolic blood pressure during the first thirty or forty minutes, and then a progressive rise in both until the end of the hour, but in no instance was the terminal reading as high as that before the administration of pitressin

CHARLES G SUTHERLAND, M B (Tor)

Pressure in the Common Bile Duct of Man Its Relation to Pain Following Cholecystectomy John M McGowan, Winfield L Butsch, and Waltman Walters Jour Am Med Assn, June 27, 1936, 106, 2227-2230

Roentgenography was used in the study of the function of the sphincteric mechanism at the lower end of the common bile duct. Direct measurement of changes in physiologic functions of the common bile duct of human beings who had disease of the biliary tract were made by the use of an especially devised manometer. Pressure necessary to force the solution into the duodenum was designated the "perfusion" pressure. When the tube to the reservoir bottle was clamped off the pressure as recorded in the manometer fell at a variable speed to a fixed level, which was referred to as the "intraductal" pressure. Choleliths (roentgenograms of the common duct filled with 5 c c of lipiodine) were made before and after the subcutaneous injection of one sixth grain (0.01 gm) of morphine to record the findings of the manometric studies.

It was found that administration of morphine produced a rise in pressure in the common duct of patients whose gall bladders had been removed. This rise in pressure was accompanied by pain in one case. Periodic rises in pressure, with pain, were demonstrated independent of the effect of morphine. Amyl nitrite and glyceryl trimyristate relieve the pain and pressure produced by morphine.

CHARLES G SUTHERLAND M.B (Tor)

GALLSTONES

Visualization of Minute Gallstones Layer Formation of Bile Alice Ettinger Am Jour Roentgenol and Rad Ther May, 1936 35, 656-661

Examination of the gall bladder in the upright position and with compression is of value especially in those cases in which the clinical and roentgenologic findings do not agree. This method may reveal small calculi which by gravity will collect at the lowest pole of the bladder, if they are of lesser specific gravity they may float in a horizontal line above the bile of greater specific gravity, which in the usual prone position may not have been seen. This method has also revealed that there is a layer formation in normal bile and whereas in the prone position much non-contrast bile may cause a faint shadow in the upright position

a normal filling is seen. The loss of non-contrast bile may thus cause an increased density of the bladder after a fatty meal.

S M ATKINS M D

GAS GANGRENE

Present Status of the X rays as an Aid in the Treatment of Gas Gangrene. James F Kelly and D Arnold Dowell Jour Am Med Assn Oct 3 1936, 107, 1114-1117

Emergency treatment of a case, using a mobile x-ray unit with what seemed a small dose when a depth factor was desired achieved such a brilliant result that eight cases have been similarly treated with startling results. The treatment was successful in cases in which the extremities were concerned, not so successful in cases in which the trunk was involved.

A second series of 32 cases treated with x rays was reviewed. Eight cases with trunk involvement in this series all lived.

The treatment should be started as soon as the disease is suspected and should be given throughout its course twice each day for at least three days, morning and evening and of sufficient voltage to insure penetration of the involved tissue. For an extremity they used from 90 to 100 kv with 1 mm aluminum filter, and for the trunk from 130 to 160 kv with increased filtration, about 100 roentgens per treatment over each area. Serum should also be used unless there is some contra indication to its use.

CHARLES G SUTHERLAND M B (Tor)

GASTRO-INTESTINAL TRACT (DIAGNOSIS)

Disseminated Polyposis of the Colon A New Surgical Treatment in Selected Cases Charles W Mayo and E G Wakefield Jour Am Med Assn Aug 1 1936 107, 342-347

Polyp is a gross anatomic term and is not intended to indicate the probable histologic structure of the tumor. Between the extremes of small excrescences on the mucous surface to pediculate tumors of varying size there are many variations in the gross appearance of these tumors. For the sake of clearness the division of Erdmann and Morris into the (1) congenital or adolescent in origin and (2) those which are acquired or of Wesson and Bargen (1) post inflammatory and (2) true is explained. The polyps of the colon that Erdmann and Morris classified as congenital or adolescent in origin are recognized by Wesson and Bargen as true polyps their cases belonging to this group.

A polyp of the intestine may prove serious in one of four ways (1) it may bleed as a result of infection or ulceration (2) it may obstruct the intestine when it has attained sufficient size (3) it may produce an intussusception and (4) most important of all it may become malignant if carcinoma is not already present when the polyp is first discovered.

Nineteen cases, confirmed by examination after surgical removal, are reported. The surgical treatment by a five stage procedure has proved the most satisfactory method in the authors' experience.

CHARLES G. SUTHERLAND, M B (Tor)

Benzedrine Sulfate and its Value in Spasm of the Gastro-intestinal Tract Abraham Myerson and Max Ritvo Jour Am Med Assn, July 4, 1936, 107, 24-26

Benzedrine is a synthetic derivative of ephedrine and in the form of benzedrine sulfate it is stable and can be administered orally. It causes stimulation of the sympathetic nervous system and has been used successfully in the treatment of narcolepsy. In non toxic doses it lessens or abolishes spastic manifestations of the gastro-intestinal tract within a few minutes. Relaxation of the sphincter permits the passage of a broad stream of the barium sulfate mixture through the pylorus and duodenum. The drug lessens the tone moderately, and diminishes peristaltic activity only slightly. The stomach actually empties more rapidly than normally under the influence of the drug. The lumen of the small and the large bowel is increased, the haustrations become broader and shallower, and contractures or irregularities due to spasm diminish markedly or disappear entirely.

The dosage for the average patient is 30 mg orally, very stout patients may require 40 mg, thin and very young individuals are given from 10 to 20 mg. It is given in tablet form with a few sips of water.

Unpleasant effects may occur in about 2 per cent of the patients.

The effect begins in about ten minutes and reaches its height in from fifteen to thirty minutes, it lessens within an hour and gradually disappears.

CHARLES G. SUTHERLAND, M B (Tor)

GENERAL BODY EXPOSURE

The Problem of General Body Exposure to Roentgen Rays C Kruchen Strahlentherapie 1936, 57, 54

A recent interest in the use of general body exposure to roentgen rays induced the author to analyze our present knowledge on this subject. He finds that there are very few data available regarding the mechanism of effect of, and the tolerance for, general body exposure to roentgen rays. There is no question but that the dosage can be regulated very accurately. The regeneration of the blood seems to be satisfactory, provided there does not exist a complicating anemia or cachexia. In leukemia and Hodgkin's disease as well as in polycythemia this technic seems to be of value. It has also been tried successfully in bronchial asthma. How much can be expected in generalized carcinoma is difficult to predict at this time. General body exposure to roentgen rays should not be given to patients with severe anemia, cachexia and diseases of the heart or kidneys.

ERNST A. POHLE, M D, Ph D

General Body Exposure with Roentgen Rays J Belot Strahlentherapie, 1936, 56, 560

The author discusses the use of general body exposure with roentgen rays in the treatment of skin lesions and malignant disease. Potentials of from 100 to 120 kv are recommended in dermatologic conditions and from 200 to 300 kv at 3.5 meters distance for deep therapy. This permits of an even distribution over an area of 1.5 square meters. No improvement in the homogeneity of radiation can be obtained by increasing the filter thickness beyond 0.5 mm Cu. Although small doses as measured in air are applied, the doses effective biologically are high because of the large surface which is exposed and because of the increase in depth dose due to the long distance.

ERNST A. POHLE, M D, Ph D

GENITO-URINARY TRACT (DIAGNOSIS)

The Roentgenological Visualization of the Male Urethra O Grimm Deutsche med Wchnschr, 1936, 62, 1671

The author relates his experience with the radiological visualization of the male urethra, using "Jodipin" as a contrast medium. The technic of the injection is described in detail. Six roentgenograms are appended showing some of the most characteristic pathology.

ERNST A. POHLE, M D, Ph D

GRENZ RAYS

Grenz and X rays, and a New Universal Therapy Apparatus Georg Jacoby Schweiz med Wchnschr, May 9, 1936, pp 464, 465

Employing a new apparatus capable of producing rays of a quality between Grenz and x-rays, the author claims to be able to produce results equal to each of these, with the additional convenience of a single apparatus. If the dermatologist wishes to employ either Grenz or x rays, the machine can readily produce these, so that all types of skin disease can be successfully treated with but one machine.

WILLIAM R. STECHER, M D

GYNECOLOGY AND OBSTETRICS

Curie Therapy of Uterine Fibroid and Hemorrhagic Metropathies I Jovin Strahlentherapie, 1936, 57, 36

The author reports his experience in the treatment of 47 cases of uterine fibroids and bleeding in 47 cases. The dose for fibroids varied from 1,400 to 4,200 mgh, depending somewhat on the size and location of the tumor. Gamma rays were used (1 mm Pt). The patients with uterine bleeding were subdivided in four groups: hemorrhage during puberty, in the child bear-

ing period, climacteric bleeding and bleeding after the menopause In the first group doses of 480-720 mgh seemed sufficient, in the second group, doses of 1 000-1 680 mgh were necessary, in the third group this was increased to 2,400-2,880 mgh In the last group the doses amounted to 4,500 mgh in order to have sufficient radiation in cases in which an intra uterine malignancy might be present

In conclusion, the author states that radium and roentgen rays are equals from the therapeutic standpoint Roentgen rays have the advantage of no mortality and no morbidity Radium therapy is indicated in cases with excessive bleeding in carcinoma of the cervix complicated with fibroid in submucous fibroids if operation is refused in uterine bleeding in virgins occasionally during the child bearing period, and in uterine bleeding during the menopause

ERNST A POHLE M D, Ph D

Roentgenologic Aid in Obstetrics E Anderes Schweiz med Wchnschr, Jan 11, 1936, pp 26 28

The author emphasizes the discrepancy between the fetal position *in utero* as depicted in text-books and as it is constantly noted roentgenographically The acute flexion of the torso, hitherto considered the position of the fetus, had been proven to be erroneous It was probably resultant of study of the prepared specimen in which fixation has caused uterine musculature contraction and pressure upon the fetus In all cases noted roentgenographically there was the appearance of relaxation of the fetus, thereby permitting rotation of the body until the last day of gestation If this motion is interfered with, due to diminished or abnormal amniotic fluid, anomalies such as club foot, etc, are prone to result Additionally, roentgenography has shown that with rupture of the amniotic sac, the fetus assumes an extended position of the vertebral column thereby aiding fetal axis pressure during delivery

A diagnosis of pregnancy can be made under most unusual and favorable circumstances as early as the eighth or ninth week, but absolute proof is not present until the eighteenth week This has become of less importance since the advent of the Aschheim Zondek test

The most practical aspect of radiology in obstetrics is pelvimetry Of the numerous complicated methods advocated the author considers only two to be of simple practical worth namely the anteroposterior projection of Martius with the patient in the semi-sitting position and the superior pelvic strait parallel to the film This is accomplished by making the distance from the top of the symphysis pubis to the table top, and from the spinous process to the table top equal A check upon this is readily accomplished by noting in the roentgenogram whether the ischial spines are situated midway between the symphysis pubis and the promontory of the sacrum An additional profile roentgenogram, as advocated by Guthmann completes the pelvimetric measurements

The sagittal plane of the conjugata vera is made parallel to the film by adjusting the patient so that the central ray is directed through both trochanters This is also a check upon the finished roentgenographic position by noting whether or not there is superimposition of the trochanters Since all these measurements are magnified and distorted, they are readily corrected by employing a simple geometric relationship between the distance of the conjugata vera to the distance of the superior strait and the target from the film Although theoretically it is as important to measure the fetal head by cephalometry, the author considers this procedure as very unsatisfactory

Roentgenograms are useful in detecting various pelvic malformations Although one can deduce with fair accuracy the age of the fetus by noting the ossification centers present, this is often a difficult procedure due to superimposition of the fetal outline upon the maternal skeleton Multiple pregnancies and fetal monstrosities are diagnosed with certainty and hydrocephalus microcephalus, and anencephaly are worthy of especial attention If the latter is demonstrated roentgenographically, the mother can be spared the chagrin and arduous labor of giving birth to a monster by the production of a therapeutic abortion Prior to Cesarean operations a roentgenogram should always be obtained to determine whether or not there is intra uterine fetal death, a condition which is readily diagnosed by noting overriding of the cranial bones of the fetal head out of proportion to the estimated time of gestation with marked extension of the fetal spine

WILLIAM R STECHER, M D

THE HIP JOINT

Fracture of the Neck of the Femur in Children Joseph I Mitchell Jour Am Med Assn, Nov 14 1936 107, 1603-1606

Fractures of the neck of the femur are relatively infrequent in children These may be divided anatomically into three types (1) epiphyseal separation (2) transcervical fracture and (3) cervico-trochanteric fracture Traumatic separation of the upper femoral epiphysis is rare the cervico-trochanteric type is the most common The fracture may be incomplete or the fragments may be impacted by the violence of the force Bony union occurs promptly as a rule but often with coxa vara deformity which causes subsequent disability of a serious nature Treatment by continuous traction combined with immobilization of the hip in abduction is advised to prevent coxa vara and shortening of the extremity

CHARLES G SUTHERLAND M B (Tor)

See also under "Fractures" page 379

HODGKIN'S DISEASE

Roentgenologic Considerations of Lymphoblastoma I—Roentgen Pulmonary Pathology of the Hodgkin's Type Carleton B Peirce Harold W Jacob and

Roscoe C Hildreth *Am Jour Roentgenol and Rad Ther* August 1936 36, 145-164

An analysis of all cases of primary diseases of the hematopoietic system other than anemia occurring at the University of Michigan Hospital between the dates of July 1, 1925, and Feb 1, 1935 was made by the writers. During this interval of approximately ten years, 681 cases have been examined. While there was a slight increase in number per year there was no relative increase when compared with the number of patients registered. There were 214 cases classified as either (1) simple Hodgkin's type, of which there were 172, (2) Hodgkin's disease with leukemia cutis, of which there were 12, (3) Hodgkin's disease with acute leukemia of which there was one, and (4) sarcomatous Hodgkin's disease of which there were 29. X-ray classification of cases based on chest radiography was as follows: (a) no chest examination, 16 cases, (b) normal chest roentgenograms, 74 cases, (c) hilar adenopathy, 22 cases, (d) mediastinal tumor, 46 cases, (e) mediastinal tumor and hilar adenopathy, 8 cases, (f) parenchymatous involvement, 6 cases, (g) parenchymatous involvement and hilar adenopathy 10 cases, (h) parenchymatous involvement and mediastinal tumor, 8 cases, (i) parenchymatous, hilar, and mediastinal involvement 3 cases, (j) pleural involvement with or without either of the above, 22 cases. There are numerous illustrations which emphasize the necessity of lateral as well as postero-anterior radiographic examinations. Quite commonly roentgenographic evidence of intrathoracic involvement is far greater than the clinical signs or symptoms of the chest disease would indicate.

Since the x ray manifestations of intrathoracic Hodgkin are so variable it follows that positive differential diagnosis of Hodgkin from other commoner intrathoracic diseases cannot be made roentgenologically. Similarly the x ray findings offer no basis for prognosis as to duration of the disease.

Approximately one-third of the cases in this series had normal chest x-ray findings.

J E HABBE M D

Roentgenologic Considerations of Lymphoblastoma II—Roentgen Therapy of Hodgkin's Disease. Harold W Jacob, Carleton B Peirce and Roscoe C Hildreth *Am Jour Roentgenol and Rad Ther*, August, 1936, 36, 165-168

In a series of 215 cases of Hodgkin's disease treated during the past decade Group I (58 patients) received repeated local irradiation. Group II (50) were irradiated over the entire lymphatic system, Group III (53) had only one or two local (obviously inadequate) treatments and Group IV (54) received no treatment in this hospital, by the authors. About the same number of each of these four groups had received some radiation before being admitted to the University of Michigan Hospital. In the first group local radiation was applied repeatedly to the areas involved with either medium or short wave length roentgen rays with dosage

from 100 to 400 r per portal, at intervals of approximately one month. In Group II general systemic radiation including all lymph gland bearing areas was employed, with medium wave length x rays to the peripheral gland structures and short wave length x-rays to the deeper glands of the chest, abdomen, and pelvis. The dosage was from 200 to 500 r per field depending upon the patient's age and general clinical condition and 12 to 15 portals, at the rate of two per day, constituted each course. This series was repeated after approximately six weeks, unless the patient had made exceptional improvement from the original series.

The irradiation of the patients in Group III was obviously incomplete, and the cases placed in Group IV were utilized as controls.

From the analysis of this series of cases the authors conclude that roentgen therapy in any degree has induced definite extension of life, as compared with untreated patients, and furthermore, that systemic radiation has accomplished a better symptomatic response than local radiation but is no more effectual than local treatments in prolongation of the total duration of the disease.

J E HABBE, M D

Unusual Complications of Lymphoblastoma and Their Radiation Treatment. Arthur U Desjardins, Harold C Haben and Charles W Watkins *Am Jour Roentgenol. and Rad Ther*, August 1936, 36, 169-179

Hodgkin's disease with primary involvement of the abdominal nodes is much more common than generally is realized. Furthermore when there is infiltration into structures in cases in which lymphoid tissue does not occur normally, many other diseases may be simulated. The writers consider chronic infection (commonly pyogenic less commonly tuberculous or syphilitic) to be the probable etiologic factor and point out that the first gland enlargement is usually in that part of the body where the infection was harbored.

Complications personally observed include fever, pruritus, infiltrations of the skin, orbital infiltrations, sternal erosions by mediastinal gland enlargements, recurrent laryngeal nerve involvement, pleural effusion, ascites edema of lower extremities infiltration of testis, bone involvement either by direct erosion or invasion, infiltration of the spinal cord or brain, and secondary infection associated with the lymphoblastoma.

Fever and pruritus usually indicate involvement of the retroperitoneal nodes, and these symptoms respond promptly with thorough radiation of the abdominal glands. In abdominal therapy four fields anteriorly and four fields posteriorly should be employed with the rays converging toward the mid-line where most of the glands are situated. Medium voltage rays (135 kv p) using 4 or 6 mm aluminum filter are preferred because of the greater safety of repeated series than when 200 kv p therapy is utilized from the beginning.

The more acute the process the less satisfactory the response to irradiation. In addition to chronicity

thoroughness of the treatment is the next most important factor in influencing the duration of the disease. Maximal doses are to be avoided, however

In cases in which the rather rare complication of secondary infection with pus formation has taken place it is important to surgically drain the pus, otherwise radiation will be ineffective

J E HABBE M D

INFECTIONS (THERAPY)

Roentgen Therapy of Some Infections Fred M Hodges and R A Berger Jour Am Med Assn, Nov 7, 1936 107, 1551-1554

This is a report of accomplishments and conclusions obtained through 17 years of experience. To offer the patient the utmost that irradiation will give there must be complete and absolute co-operation between the co workers

Various lesions were collocated in accordance with their sensitivity or susceptibility to irradiation as follows Group 1, Early localized erysipelas in adults, furuncles and furunculosis granulomas, infected hemangiomas, cellulitis of certain types, Mikulicz's disease, parotitis and rhinophyma Group 2 embraced carbuncles, blastomycosis, and sporotrichosis

Group 1 comprises those infections which are sufficiently amenable to irradiation to render no other form of therapeutics necessary The lesions respond so readily that one may predict an immediate amelioration or abortment, followed by rapid regression and healing

In Group 2 they have placed those infections in which irradiation is an important auxiliary in the armamentarium for the management of these lesions

Different types of lesion and similar lesions in different stages of development react somewhat differently to roentgen rays The technic employed is not empirical every case is individualized and treated accordingly

CHARLES G SUTHERLAND, M B (Tor)

INFLAMMATORY DISEASES

Fibrositis W S C Copeman Jour Am Med Assn, Oct 17 1936 107, 1295-1297

Fibrositis is the term given to an inflammatory reaction of fibrous supporting tissue to extraneous poisons either toxic or bacterial It is characterized by nodular or bandlike thickenings in the affected fibrous tissue in the fascia lining the muscles or joints or sometimes embedded in the substance of the muscles themselves In the latter case they can be felt only when the muscles are in a state of relaxation after the passing of the acute attack

Fibrositis may attack fibrous tissue wherever it is situated and since such tissue may occur almost anywhere in the body the manifestations of this disease are protean

Roughly the situations in which it occurs with frequency may be thus classified (1) Subcutaneous tissue (panniculitis) which will include the areolar and adipose tissue found in this situation. (2) Intramuscular, which will include inflammation of the tissue that separates the fascial muscular planes (myositis), the lining of the bursae (bursitis), and the periarticular fibrous tissue (capsulitis) (3) The fibrous sheaths of the chief nerve trunks such as the sciatic or the brachial nerves (interstitial neuritis)

Fibrositis is most common in sites in which a combination of strain and chill occur most usually Common situations are therefore the lumbar region (lumbago), the back of the neck, the shoulder the scalp (rheumatic headaches) and the elbow (certain forms of tennis elbow) Less common sites which when affected often give rise to mistaken diagnoses are the attachment of the rhocostalis muscle to the lower six ribs and the subcutaneous tissue of the precordial area

Biopsy reveals no typical pathologic structure. Whatever the actual etiology of fibrosis may be, the background will nearly always be found to reveal chronic fatigue or strain

Clinically there appears to be two stages in most cases of fibrositis (1) The stage of effusion, in cases in which this is superficial, a puffy swelling may be seen (2) the stage of organization during which the serofibrinous exudate gets partially absorbed while the residue becomes invaded by fibroblasts and a low grade fibrosis results forming intramuscular and interfascial adhesions and, later, palpable nodules A further frequent complaint is of muscular stiffness, which generally persists even after the pain has disappeared

Lewellyn in the majority of his cases, confirmed the presence of either enlarged or shrunken thyroid glands.

Treatment includes a salt free diet increase of fluid intake, heat and massage

CHARLES G SUTHERLAND, M B (Tor)

THE INTESTINES

The Small Intestine Eugene P Pendergrass Jour Am Med Assn, Dec 5 1936 107, 1859-1861

It is essential that collective studies be made of the small intestine in healthy individuals and in patients having lesions of the small intestine Lesions involving other portions of the gastro-intestinal tract as well as conditions outside of it may exert a profound influence on the mechanics and pattern of the small intestine Any investigation therefore, should include a consideration of all such factors The author presents a plea for a standard meal so that one radiologist may compare his results with those of another The pattern of the small intestine will vary considerably depending on the composition of the foodstuff it receives It varies also with the consistency of the meal its size the gastric emptying time and the tonicity of the intestinal tract Certain pathologic conditions which only indirectly affect the intestinal tract may cause a profound change in the small intestine pattern

The author recommends a meal consisting of 5 ounces (140 gm) of barium sulphate and 5 ounces (150 c.c.) of water. The normal stomach empties such a meal in the majority of instances within two hours, occasionally the period is as long as three hours. The head of the column reaches the cecum occasionally in one and one half hours. In most instances it requires from two to three hours to reach the cecum and from four to six hours for the intestine entirely to empty itself.

The mucosal pattern is described in detail in the different portions of the small bowel. The upper three-fifths of the small intestine consists of jejunum, and this generally lies to a large extent in the left side of the abdomen. The lumen varies in size in fat and thin individuals and in men and women.

The examination of the small intestine requires several hours as a rule, and occasionally its physiologic function is disturbed as a result of the patient having developed a headache because of food being withheld. Psychic or emotional disturbances may apparently influence the motility and pattern of the small intestine. Normal variations and anomalies were found more frequently than anticipated.

The radiologist should be extremely careful in attempting to identify for the surgeon the point of obstruction in the small intestine.

Various drugs were found to have a profound effect on the gastro-intestinal tract for from twenty-four hours to five days.

A large group of other lesions that disturb the normal physiology reflexly are being studied to be reported later.

CHARLES G. SUTHERLAND, M.B. (Tor.)

THE LUNGS

The Middle Lobe of the Right Lung. Its Roentgen Appearance in Health and Disease. Aubrey O. Hampton and Donald S. King. *Am. Jour. Roentgenol.* and *Rad. Ther.* June 1936, 35, 721-739.

The writers describe the roentgenologic findings in 56 patients suffering from disease of the right middle lobe, 41 of whom were operated on or had postmortem examination, while 15 had bronchoscopy or lipiodol bronchography only. Particular consideration is devoted to the appearances of various pathologic processes as shown on the right lateral film.

First attention is given to the applied roentgen anatomy, and it is pointed out that in cases in which the lesion has more or less the distribution of the lateral aspect of the lobe a triangular shadow will be produced on the lateral roentgenogram, but if the lesion follows the distribution of the medial part of the lobe a more rectangular shadow will result. A lesion of the latter distribution will obscure more or less the right heart border and render cloudy the right cardiophrenic angle.

Primary encapsulated interlobar empyema is now considered a rarity by the writers as in the entire series not a single proven case was found. Lung abscess in

the same region is fairly common by comparison. A warning is offered against the careless misinterpretation of interlobar empyema when actually there is no lesion in this vicinity but merely an overlap of the right diaphragm and posterior aspect of the heart in such a way as to give a shadow simulating effusion. This appearance is most readily obtained if for any reason the right diaphragm is abnormally elevated.

Not infrequently, the right middle lobe is so fibrosed and collapsed as to be of no more than two to three centimeters in greatest thickness in lateral projection, in such cases interlobar pathology is apt to be diagnosed mistakenly. The demonstration of the interlobar pleural septa is of great importance in making for correct differential diagnosis, although at times bronchoscopy or bronchography is absolutely essential to a final diagnosis.

J. E. HABBE, M.D.

Concerning the Symptomatology of Congenital Cystic Pulmonary Disease (Honey-combed Lung). F. H. Weis. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, September 1936, 54, 230-237.

This is a report of two cases of this relatively rare disease with considerable references to the literature (Zdamsky, Lenk, Camigiani, etc.). One of these patients was under observation for over nine years and in spite of repeated intercurrent infection ultimately showed no progress in numerous pulmonary cysts. Roentgen therapy, collapse therapy, and paralysis of the diaphragm were without influence. The other patient, representing the type of small, rounded and polyhedral cysts throughout both lungs, succumbed to intercurrent infection (tuberculosis) and could be studied carefully at autopsy. This infection involved only the right middle lobe. It is assumed that in this case a chronic peribronchitis led to progressive interstitial induration with subsequent alveolar ectasia. The necessity of etiologic diagnosis of pulmonary cavities is apparent.

H. A. JARRE, M.D.

OSTEOMYELITIS

Osteomyelitis at Cook County Hospital with an Appraisal of Orr's Method of Treatment. Marcus H. Hobart and Donald S. Miller. *Jour. Am. Med. Assn.* Oct. 3, 1936, 107, 1118-1121.

The authors present an appraisal of Orr's method of treatment in this institution. More than 375 patients were operated on and of these only one-third have answered the follow-up requests to return for a final check up. The cases reviewed number 108, with 135 admissions to the hospital, the majority occurred in adults between the ages of 20 and 40. The Orr method gave 62 per cent symptom free results in these cases.

CHARLES G. SUTHERLAND, M.B. (Tor.)

thoroughness of the treatment is the next most important factor in influencing the duration of the disease. Maximal doses are to be avoided, however.

In cases in which the rather rare complication of secondary infection with pus formation has taken place it is important to surgically drain the pus, otherwise radiation will be ineffective.

J E HABBE M D

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Fibrositis is most common in sites in which a combination of strain and chill occur most usually. Common situations are therefore the lumbar region (lumbago), the back of the neck, the shoulder the scalp (rheumatic headaches) and the elbow (certain forms of tennis elbow). Less common sites which when affected often give rise to mistaken diagnoses are the attachment of the iliocostalis muscle to the lower six ribs and the subcutaneous tissue of the precordial area.

Biopsy reveals no typical pathologic structure. Whatever the actual etiology of fibrositis may be, the background will nearly always be found to reveal chronic fatigue or strain.

Clinically there appears to be two stages in most cases of fibrositis: (1) The stage of effusion, in cases in which this is superficial, a puffy swelling may be seen, (2) the stage of organization during which the serofibrinous exudate gets partially absorbed, while the residue becomes invaded by fibroblasts, and a low grade fibrosis results forming intramuscular and interfascial adhesions and later, palpable nodules. A further frequent complaint is of muscular stiffness which generally persists even after the pain has disappeared.

Lewellyn in the majority of his cases confirmed the presence of either enlarged or shrunken thyroid glands.

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of the grade of the defect. A correct posture appears to be an appreciable advantage to circulatory and respiratory function in the majority of persons, but in some a postural defect may be a compensatory mechanism which it is inadvisable to disturb. The therapeutic application of postural correction should be made according to the requirements of the individual case, and only after an attempt to determine in what posture the individual is functionally most efficient.

CHARLES G. SUTHERLAND, M.B. (Tor.)

sumption of prostatic malignancy 16 cases were referred, but on the basis of the resulting reaction and cure, the diagnosis had to be corrected to that of inflammatory prostatitis.

From his observations the author comes to the conclusion that prostatitis is one of the most gratifying conditions for well directed roentgen therapy, in the acute as well as chronic state. In dubious cases of malignancy, radiation therapy would seem justifiable for therapeutic and diagnostic purposes.

H. A. JARRE, M.D.

THE PROSTATE

Roentgen Therapy of Prostatitis. J. Palugyay. Fortschr. a. d. Geb. d. Röntgenstrahlen, September, 1936, 54, 215-218.

This report is based on a study of 76 cases of which eight were afflicted with acute or subacute prostatitis, 41 with a chronic infection, in 11 cases the infection occurred in a hypertrophic prostate, and 16 cases were referred for radiation therapy under the assumption of a malignancy in the gland. Seven of the acute cases harbored an urethrogenous infection, while in the eighth case it followed a severe cellulitis of the hand. Six of the 41 chronic cases harbored a gonorrheal infection, some of them a mixed infection, in three cases a so called aseptic prostatitis had to be assumed.

Six of the eight acute cases were cured by a single series of radiation. After an unsuccessful first series, the two other patients did not return for further observation or treatment. Of the 41 chronic cases, 15 were cured by one series, though a second series was given to six of them to secure complete disappearance of subjective distress. Eight further cases were cured subjectively and objectively by two series, three additional cases by three series of radiation. In two cases an abscess had to be drained after the first series of radiation. Four cases developed a recurrence after the first series and required a second series of treatment several months later. In six cases no effect of any kind was obtained by the first series of radiation and this method of treatment was then discontinued. In three cases there was an aggravation of symptoms rather than an improvement.

Thus a cure was obtained by from one to three series of radiation in more than 75 per cent of acute and chronic cases, 22 per cent of the cases showed no effects. In three cases an aggravation occurred.

Technic.—Small doses, highly filtered irradiation, large field of entry, total dosage—the smaller, the more intense the inflammatory reaction. On admittance from 20 to 60 r from a large suprasymphysal field and equal amounts to a sacral field from six to eight days later to which may be added if necessary, a smaller perineal field following an additional interval of from three to six days. The series may be repeated after three weeks at which time the total dose may be increased somewhat.

Quite frequently a considerable irradiation reaction is observed even after such small doses. Under the as-

RADIOLOGY, PRACTICE OF

What the Radiologist Should Know about Clinical Pathology. Karl Kornblum and Henry J. Tumen. Am. Jour. Roentgenol. and Rad. Ther., August, 1936, 36, 202-232.

In his effort to become master of the art of roentgenology the radiologist is apt to forget much of the general medical knowledge which he learned in undergraduate days or before limiting his work. Furthermore, as the years pass there is much that is new in all the specialties and it is difficult for the radiologist to keep abreast of all these advances. Clinical pathology is one of the most important specialties concerning which he should keep informed. It is with the idea of fulfilling in part this need that the writers present this material with a page and a half summary at the end in table form, of a number of ranges of normal in laboratory tests of the blood, the stomach contents, and the liver, gall bladder, and kidney functions.

Concerning blood examinations, the reporting of hemoglobin determinations in grams per 100 c.c. is advocated in preference to percentage.

Since most malignant tumors are accompanied by an increased sedimentation rate, this test is advocated as a means of aiding in the differential diagnosis of tumors.

In cases of anemia in which there is a pathologic condition of the bone marrow irradiation should be given with caution. However, there is no substantial proof to date that the diagnostic use of thorotrast will cause injury to the blood or bone marrow.

The writers also prefer to see differential counts of the white blood cells in actual number per centimeter rather than in percentages.

In considering blood chemistry, it is pointed out that the most common extra renal cause of an increase of urea nitrogen is acute high intestinal obstruction.

If liver disease can be excluded the serum phosphatase determination may be of special value in studying bone diseases. For example, in Paget's the phosphatase is markedly elevated. The same is true of hyperparathyroidism. In myeloma there is lesser elevation.

In Schüller-Christiansen syndrome a condition dependent upon a hyperlipemia there is usually also a hypercholesterolemia.

The presence of alkalosis may aid materially in final evaluation of obstructive lesions at the pylorus found

Acute Hematogenous Osteomyelitis An Analysis of 75 Cases Robert Crawford Robertson Jour Am Med Assn, Oct 10 1936, 107, 1193-1199

The essential pathologic condition in acute hematogenous osteomyelitis is a blood stream infection complicated by local infection of one or more bones. The author presents a review of 75 successive unselected, private, and clinical cases treated within the past nine years. Definitely acute hematogenous, pyogenic cases only were included. Twenty-two days was arbitrarily chosen as the time limit in determining acuity. The principle of early drainage was followed in all of these. Early roentgen changes were seen as early as the fifth day and were absent as late as the fourteenth day following onset in one case.

The majority of the best results were obtained by drainage of the bone within one week following the onset. The mortality rate was also highest in cases in which drainage was instituted within this period.

CHARLES G SUTHERLAND, M B (Tor)

Bone Growth Disturbance Following Hematogenous Acute Osteomyelitis John C Wilson and Francis M McKeever Jour Am Med Assn Oct 10 1936 107, 1188-1193

This is a review of 64 patients with 90 individual foci of infection who suffered from acute hematogenous osteomyelitis. Fifty nine in this group showed involvement of the long bones with a diaphysis and one or more terminal epiphyses. Five cases showed the lesion in the os calcis which grows by accretion and has no diaphysis or terminal epiphyses.

The growth disturbances occurring in the long bones were classified as follows: (1) Primary variations (a) perimetric hypertrophy, (b) lengthening, (c) shortening, (d) directional changes (coxa valga and antero-posterior and lateral bowing); (2) Secondary variations, disturbance of joint inclination (genu valgum, medial deviation of the ankle or lateral deviation of the ankle); (3) Concomitant variations compensatory lengthening of uninfected paralleling bones and shortening and diminution of size of feet without infection in any of the component osseous structures.

Early operative intervention in this series did not decrease the frequency of growth disturbances.

CHARLES G SUTHERLAND M B (Tor)

PEPTIC ULCER

A Review of the Gastric Ulcer Problem Sara M Jordan Jour Am Med Assn Oct 31 1936 107, 1451-1456

The author reviewed 119 cases in which the diagnosis of gastric ulcer was made on a reasonable basis and checked by surgical exploration in 31 cases or by follow-up studies varying from a few months to eleven and one half years after medical treatment.

After the data of history and chemical changes were analyzed and their adjuvant value estimated, the x ray examinations assume the decisive role in differentiation. The important x ray criteria are of two kinds: (1) the original appearance of the lesion by x rays and (2) changes in the original appearance of the lesion with trial treatment. It is undoubtedly true that the lesion of the pars media which appears in the original x ray examination as the protruding crater off the lesser curvature in the pars media and without involvement of the posterior wall is practically always benign and shows a tendency to relatively quick healing with synchronous diminution of the size of the crater. Complete healing occurs when there is complete disappearance of the crater.

With all the diagnostic data (history, chemistry, and x-ray examinations) at hand, one is still not infrequently doubtful as to the benignity of the lesion. Safeguards are a limited period of trial management and a careful follow-up of all cases.

CHARLES G SUTHERLAND, M B (Tor)

Permanence of Cure Following Ruptured Duodenal Ulcer Donald Guthrie and Robert F Sharer Jour Am Med Assn Sept 26 1936 107, 1018-1022

The authors discuss the opinion of various schools as to the best procedure in acute perforation of a duodenal ulcer. They review their own series of 78 cases, four operated on outside the hospital and 74 treated in the hospital over a 26 year period.

Pneumoperitoneum determined by correct fluoroscopic examination was of distinct value in many cases, and Singer and Vaughan are quoted as maintaining that it is effective in 86 per cent of their cases proved by operation. The treatment employed in their cases was one of simple closure, a gastro-enterostomy being performed at a later date only if obstruction developed. Four patients, however, required a gastro-enterostomy at the first operation because of obvious obstruction of the duodenum. Their operative mortality was 20.8 per cent.

CHARLES G SUTHERLAND M B (Tor)

POSTURAL DEFECTS

Physiologic Effects of the Correction of Faulty Posture. Louis B Laplace and Jesse T Nicholson Jour Am Med Assn Sept 26 1936 107, 1009-1012

Observations were made on a series of 28 healthy adults of both sexes having disorders of the back attributable to postural strain.

Twenty three subjects were studied with respect to the immediate physiologic effects of changing from a faulty posture to a corrected posture. Eight of these were further studied with respect to the degree of permanence of these effects following a year of routine corrective exercises.

It was concluded that the results of correcting faulty posture differ widely between individuals irrespective

cal pulmonary tuberculosis in those with anthracosilicosis was 15 per cent in the early cases and 43 per cent in the late well established cases. Among the controls and those essentially negative for anthracosilicosis, the prevalence was, respectively, 1 and 2 per cent, or about the same as in the general population.

CHARLES G. SUTHERLAND, M.B. (Tor.)

THE SKIN

Severe Xerostomia from X-ray Treatment for Hypertrichosis. Sigmund S. Greenbaum and Henry Tumen. Jour. Am. Med. Assn., Oct. 17, 1936, 107, 1297.

In various parts of the United States a number of patients with untoward cutaneous complications from the use of the commercialized Tricho (x-ray) System in the treatment of hypertrichosis of the face have been observed. Filtered x-rays obviated the superficial complications such as cutaneous atrophy and telangiectases so commonly seen. It was, however, followed by deep effects on the salivary glands of the oral mucous membrane and their secretions.

The authors report a case of a woman treated by a "cosmetologist" with progressive development of oral dryness.

CHARLES G. SUTHERLAND, M.B. (Tor.)

SOFT TISSUE ROENTGENOGRAPHY

Air Injection of the Fascial Spaces. A New Method of Soft Tissue Roentgenography. Preliminary Report. Charles Murray Gratz. Am. Jour. Roentgenol. and Rad. Ther. June 1936, 35, 750-751.

Air injections into the fascial spaces are described by the writer in this preliminary report. Like the encephalogram, the "pneumofasciogram" may have both diagnostic and therapeutic value. Fascial adhesions may produce certain restriction of motion and will cause certain abnormal distribution and irregularity of the air shadow. The freeing of adhesions by this diagnostic procedure may account for the therapeutic benefit that the writer has seen in some cases. The procedure should take place in the operating room and the patient should remain hospitalized from 24 to 48 hours.

J. E. HABBE, M.D.

THE STOMACH

Diagnostic Aspects of Roentgenologically Negative Gastric Disorders. George B. Eusterman. Jour. Am. Med. Assn. Oct. 31, 1936, 107, 1432-1436.

The efficiency of modern roentgenologic diagnosis permits classification of diseases of the stomach into roentgenologically positive and roentgenologically negative disorders.

The former (ulcer, cancer, and so on) constitute about a fifth of the cases of chronic dyspepsia coming under observation at the clinic, roentgenologically negative disorders which have been classified and described constitute the remainder.

Gastric disturbances reflexly engendered by disease of the abdominal viscera other than the stomach itself or its continuations exceed in importance the gastric neuroses, because of their nature and extent and the comparative frequency of their occurrence. They constitute from a third to two-fifths of all cases. The neuroses constitute about a fourth of the total.

CHARLES G. SUTHERLAND, M.B. (Tor.)

THE TEETH

Chronic Endemic Dental Fluorosis (Mottled Enamel). H. Trendley Dean. Jour. Am. Med. Assn., Oct. 17, 1936, 107, 1269-1273.

The endemic hypoplasia of the permanent teeth known as chronic endemic dental fluorosis, or mottled enamel, is a water-borne disease associated with the ingestion of toxic amounts of fluorides in the water used for cooking and drinking during the period of calcification of the affected teeth. The permanent teeth in particular are affected, although in areas of medium to marked severity the signs of mottled enamel are at times observable on certain of the deciduous teeth.

Mottled enamel is a permanent physical disfigurement. The distribution is world-wide. The most severely affected State in the United States is Texas. Among the foreign countries the Argentine Republic is the most seriously affected.

In spite of their defective structure, mottled enamel teeth exhibit no greater liability to caries than do normally calcified teeth.

In the light of present knowledge this disease is readily preventable. The logical approach to the solution of this problem is avoiding the use of water containing fluorides in excess of the permissible limit. In some instances this can be accomplished by simply changing to a readily available source in the same neighborhood that is free from toxic amounts of fluoride. The water may be diluted to bring the fluoride content down or the water supply may be treated by chemical means for the removal of toxic amounts of fluorides.

CHARLES G. SUTHERLAND, M.B. (Tor.)

THE TONSILS

Changes in the Bacterial Flora of the Tonsils Induced by Roentgen Therapy of Cases Afflicted with Chronic Tonsillitis. E. D. Dubowyn and N. M. Gordijan. Fortschr. a. d. Geb. d. Röntgenstrahlen. January 1936, 53, 73-76.

The bacterial flora of 79 patients afflicted with chronic tonsillitis was investigated before and after roentgen irradiation up to four months after treatment. The following results were reported:

roentgenologically If there is an alkalosis associated with an obstructive lesion at the gastric outlet the lesion is probably benign, since in most cases of benign ulcer there is a hyperacidity and the vomiting will cause a loss of chlorides Conversely in malignancies with achlorhydria there is no chloride loss and no alkalosis

Gastric analysis curves are important in duodenal ulcer in which lesion from 70 to 80 per cent of the cases there is a sharp rise in free HCl which remains elevated in the first hour and may go even higher in the second and third hours and in gastric carcinoma, in from 60 to 80 per cent of which cases there is an achlorhydria

Concerning liver tests, it is emphasized that there is no functional test which if negative will entirely rule out advanced hepatic disease

Gall bladder drainage and cholecystography are not antagonistic but if used jointly will often supplement one another in diagnostic information If by gall-bladder drainage one can demonstrate cholesterol crystals and the orange pigment of what is probably calcium bilirubinate, one may be nearly 100 per cent certain of the presence of gallstones The absence of concentrated B bile in repeated drainages constitutes good evidence of disturbed gall-bladder function

J E HABBE, M D

RADIUM

Treatment of Intracellular Tumors by Radon W O Lodge British Med Jour, Dec 19 1936 pp 1257, 1258

The author describes his experience and operative technique with radon seed implantation in treating intracellular tumors A case is described in which the patient was well two years after the operation

G E BURCH M D

Mild Radium Therapy F Howard Humphris British Med Jour Sept 12, pp 532-535

Various methods are discussed for collecting and using radium emanation in practice The author considers it beneficial in (1) gout and goutiness, (2) certain gynecological conditions as pelvic pain and congestion salpingitis and in the treatment and cure of sterility, (3) certain dermatological conditions as psoriasis mycosis fungoides eczema and lichen, (4) chronic catarrhal conditions and affections of the sinuses and respiratory organs and (5) for revitalizing in convalescence notably from septic troubles It is eminently suitable in the complaints of middle and old age premature aging more especially in recuperation in cases of exhaustion or weakness following operation long illness or overwork

He discusses the various theories by which radon gas is said to produce its beneficial results He concludes These findings suggest as a possible rationale for

emanotherapy, that the emanation, by virtue of its positive and negative charges, may remove the electric charges from the body colloids and have a stabilizing action resulting in a sedative effect on the tissues The rationale of the radon treatment of rheumatism is one of oxidation and detoxication and there is no doubt but that treatment by mild radium therapy does raise the patient's resistance in a remarkable way "

G E BURCH, M D

ROENTGEN-RAY BURNS AND INJURIES

Erysipelas Carcinomatosum Resembling Radiodermatitis George E Pfahler Am Jour Roentgenol and Rad Ther, June, 1936 35, 804-812

Since in most cases at least, this form of malignancy develops independent of x ray therapy or other local application, it is reasonably certain that irradiation has nothing to do with the condition Nevertheless it is sometimes misdiagnosed as radiodermatitis or radiotelangiectasis While in some cases the disease extends through the blood vessels of the skin by direct permeation the more common route is through the lymphatics of the skin and subcutaneous tissue Microscopic study of biopsy material shows collections of cancer cells in the corium with no invasion of the epidermis The clinical appearance is that of malignant disease with an inflammatory reaction Roentgen irradiation may give definite improvement, although in 15 cases examined and treated by the author none was permanently cured

J E HABBE M D

SILICOSIS

Anthracosilicosis Waldemar C Dreessen and R R Jones Jour Am Med Assn. Oct 10 1936 107, 1179-1185

This is a study based on practically all the personnel of three representative mines engaged in mining and processing of hard coal in Pennsylvania numbering 2 711 tuberculosis free disabled former anthracite workers in hospitals intensively investigated and limited observations on the disease as observed in a tuberculosis sanatoriums in Pennsylvania The last occupation listed was the miner's present job The weighted average dust exposure in each job was multiplied by the number of years in that occupation The sum of all these products divided by years in the industry, gave a fairly accurate estimate of the man's average exposure The workers were divided chiefly into three groups (1) Regular miners exposed to a dust with a free silica content of from 3 to 4 per cent (2) Workers in the haulage ways exposed to dust with a free silica content of 13 per cent (3) Rock tunnelers and muckers exposed to 35 per cent free silica

Of this group of 2 711 they found 616 (22.7 per cent) affected with anthracosilicosis The prevalence of clinical

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WHY PNEUMOPERITONEUM?¹

By IRVING F STEIN, M D, Associate Professor of Obstetrics and Gynecology, Northwestern University Medical School, Attending Physician, Department of Obstetrics and Gynecology, Michael Reese Hospital, Chicago

FOR the past thirteen years, I have made pneumoperitoneal diagnosis a part of my gynecologic armamentarium and have come to feel that it is one of the most valuable diagnostic procedures we possess. In cases of difficult or obscure diagnosis and in gynecologic differential diagnosis, the pelvic pneumogram has frequently been the means of establishing the true status. Visiting physicians and students are usually startled at the clarity with which the pelvic organs are revealed on the roentgen film and they express amazement that hospitals in general and medical schools in particular do not utilize and teach this method of diagnosis. All who have seen the results of pneumoperitoneum appreciate its value, but they harbor an unwarranted apprehension of harmful effects from the procedure.

Roentgen diagnosis is a relatively recent acquisition in both obstetrics and gynecology. In obstetrics, technical difficulties and the fear of fetal injury had to be overcome before general acceptance of x-ray examination was accomplished (1, 2). The obstetrician now welcomes this diagnostic aid in solving many clinical problems. On the other hand, the gynecologist does not feel the need for roentgenographic corroboration because, as a rule, he is satisfied with a diagnosis achieved by means of

a history and a bimanual examination. Even to-day, when pneumoroentgenography has been utilized for over twenty years and uterosalpingography for more than ten years, there are many physicians practising gynecology who are skeptical of the need for these methods. Furthermore, there still appears to be a doubt as to their value and there exists an unfounded fear of danger in their application. The favorable results obtained in cases of sterility following the use of gas or iodized oil for testing tubal patency have tended to overcome to a great extent the doubts concerning uterotubography in this condition. There still exists, however, some fear of injury to healthy fallopian tubes or pelvic peritoneum by the iodized oils employed as contrast media, although evidence is lacking to substantiate this misapprehension. I have examined many histologic sections of normal fallopian tubes removed after lipiodol instillation and have not found evidence of inflammatory change (foreign body giant cells) resulting from iodized oil. The few instances of complications resulting from long retention of lipiodol which have been reported in the literature occurred in cases of chronic tubal inflammation in which the oil lodged in closed cavities. Many gynecologists who admit the merits of roentgen diagnosis in this field nevertheless feel that the method employed makes demands upon their time which they are unwilling to allow.

¹ Presented before the Radiological Society of North America at the Twenty second Annual Meeting at Cincinnati, Nov. 30-Dec. 4 1936.

Group 1—This group consisted of 54 cases afflicted with chronic tonsillitis but without disease of the internal organs or joints. Before roentgen therapy, 27 cases showed the presence of hemolytic streptococcus, in 19 cases (70.4 per cent) this infection disappeared after the first treatment, while *Streptococcus viridans* disappeared in seven of twelve cases, and *Staphylococcus aureus* in six of nine cases.

Group 2—This group consisted of 11 patients with chronic tonsillitis and disease of the internal organs, or bones and joints. *Streptococcus hemolyticus* disappeared in five of eight cases, *Streptococcus viridans* in three of five, and *Staphylococcus aureus* in six of nine.

Group 3—This group consisted of 14 children with high-grade tonsillar hyperplasia and respiratory difficulties but without angina. No pathogenic microorganisms were present in the tonsils, either before or after roentgen irradiation.

Treatment employed consisted of 210 kv., 4 ma., 0.5 mm. of copper plus 2 mm. of aluminum, 25 cm. focal-skin distance, size of field 4 × 5 cm. in children, 5 × 6 cm. in adults, over the mandibular angle. Children from 5 to 10 years of age received 25 per cent of a skin erythema dose, 10 to 15 years of age, 30 per cent, older ones, 33 to 35 per cent. One skin erythema dose equaled 640 r. A second series of treatments was given usually one month after the first.

H. A. JARRE, M.D.

TULAREMIA

Primary Tularemic Ulcers in Pharynx F. H. McGovern. Jour. Am. Med. Assn., Nov. 14, 1936, 107, 1629, 1630.

Tularemia is primarily a fatal disease of rodents, chiefly rabbits and is secondarily transmitted to man from rodents by the bite of an infected tick and other blood sucking insects, by contamination of the hands with infected material or by the ingestion of improperly cooked infected meat. It occurs in four main types: ulceroglandular, oculoglandular, glandular, and typhoidal. The ulcers are chronic indurations resembling the primary lesion of syphilis, appearing after an incubation period of from one to nine days, and accompanied by chills, high fever, sweating, headache and prostration. The regional adenopathy, often quite large and frequently suppurative, may appear before the primary lesion is apparent. Pulmonary manifestations consisting of pulmonic consolidation, bronchitis, or pleural effusion may follow the initial symptoms. A moderate

leukocytosis with a distinct shift of the Schilling count to the left is found. A diagnosis is ordinarily confirmed by a positive agglutination reaction of the serum against *Bacterium tularensis*. This reaction becomes positive generally in the second or third week and persists indefinitely.

One case is reported with primary ulcerations in the pharynx and bilateral cervical adenopathy, the inoculation presumably occurring from crushing an infected dog tick and carrying the organisms to the mouth on the fingers.

CHARLES G. SUTHERLAND, M.B. (Tor.)

TUMORS (DIAGNOSIS)

Some Discrepancies and Pitfalls that Occur in Clinical Work as the Result of the Grading of Tumors F. W. Konzelmann. Am. Jour. Roentgenol. and Rad. Ther., June, 1936, 35, 795-803.

Reasons for discrepancies between histologic grading of degree of malignancy by the Broders' method and the end-result of treatment are discussed. A single biopsy may be misleading as to the predominating cell type, hence the tumor grade. Moreover Broders' original work was done on material which did not have the advantage of modern x-ray and radium therapy. Again the biopsy will give no clue as to whether metastasis has occurred or not, a fact of obvious vital importance in arriving at a prognosis.

In lip cancer, while in a general way size of the lesion is comparable with duration of tumor and degree of malignancy, the coincidence is not sufficiently frequent to permit grading on any one factor.

According to some workers changes in grade may occur in metastasis. In the opinion of others, histologic grading has been unsatisfactory both as a means of estimating prognosis and for determining radiation dosage.

Even in the hands of a group of expert tumor pathologists histologic grading resulted in an accuracy of only about 50 per cent as compared with the clinical follow-up in a series of 100 breast tumors.

There are, of course, many well known exceptions to Bergonié's law which states that the more anaplastic tumors are, the more radiosensitive they are. The situation is made worse by misapplication of the terms 'radiosensitivity' and 'radiocurability'.

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They are willing however, to subject their patients to exploratory laparotomy which might be unnecessary. There is no denying the fact that time and patience are required of both gynecologist and roent-

in the majority of gynecologic conditions. But there are many cases in which the diagnosis is obscure in which the *unusual methods* must be employed. For instance, when the question of pregnancy is involved,

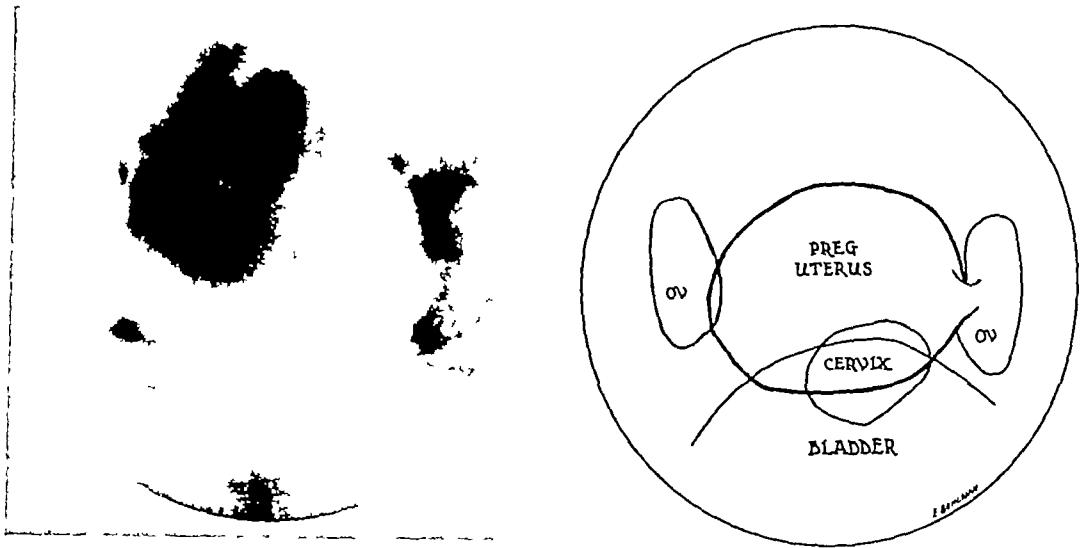


Fig 1 Transabdominal pneumoperitoneum Pregnancy 10 weeks

genologist for lipiodol instillation, induction of the pneumoperitoneum, roentgenography, and particularly for the interpretation of the films. That I consider it time well spent is attested to by the fact that I am still enthusiastic over the methods after an experience of thirteen years, during which I have used them in about 800 patients. During this time, I have indeed been fortunate in the continued co-operation, assistance, and encouragement of my colleague, Dr R. A. Arens, Director of the Roentgenological Department of Michael Reese Hospital.

DIAGNOSTIC VALUE

Like other laboratory methods, the roentgenogram is employed to complement the data obtained by history and physical examination and thereby support, or at times, refute a previous diagnosis. It is not used in lieu of other diagnostic measures, nor have I employed it as a matter of routine. As previously stated (3), the usual history, bimanual and specular examination suffices to arrive at a diagnosis

it is often not sufficient to determine whether pregnancy is present, but also to determine whether the implantation is intra- or extra-uterine. The biologic test (Friedman) may be employed and, after 48 hours, a reasonably reliable report may be obtained as to whether pregnancy exists, but this does not indicate the location of the nidation. Moreover, in the early weeks, this test may prove negative and if the embryo is dead, as in missed abortion or tubal mole, the result may be misleading. By palpation, one may find a uterus somewhat enlarged and a unilateral tenderness so acute as to lead to a suspicion of tubal pregnancy. Cul-de-sac puncture, blood counts, sedimentation tests, and other diagnostic procedures may prove to be of value, but comparatively, it is my opinion that no test is so valuable as *transabdominal pneumoperitoneum*. In making a differential diagnosis in such cases in which pregnancy is a consideration, I have successfully employed pneumo-roentgenography and thereby established the true diagnosis. The following examples

abstracted from my records describe (1) intra-uterine pregnancy, (2) corpus luteum cyst, and (3) unruptured tubal pregnancy in cases in which, prior to the roentgen examination, the diagnosis was in doubt or

the size of a 10-12 weeks' gestation, with a firm, globular right horn. No adnexal mass was palpable. The isthmus uteri and cervix were soft, and the cervix appeared bluish to inspection. The breasts

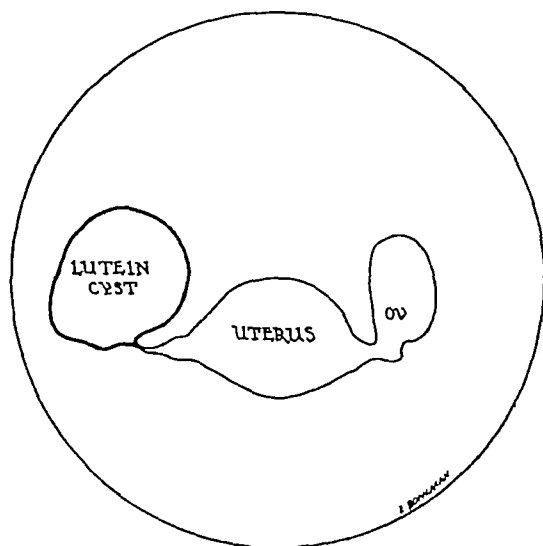


Fig 2 Transabdominal pneumoperitoneum Lutein cyst of ovary

dispute. The film in each instance was the deciding factor in arriving at the correct diagnosis.

Case 1 Mrs G F, gr vii, para iv, three induced abortions (1932, 1934, and Feb 8, 1936). Menses began at 12 years of age and were of the regular 28-day interval and of four days' duration until the past year, when menses were 23 to 33 days. Last normal period on Jan 2, 1936, preceded by spotting for five days. Visited a physician on Feb 8, 1936, for purpose of re-establishing periods. After the treatment, bled for one day. Patient was examined at a prominent university clinic where, on first examination, the chief of the clinic diagnosed *uterine fibroids*, but advised that repeated examination be made. A few days later she was told by the same physician that she had a *tubal pregnancy*. She appeared at my offices on March 4, 1936, complaining of backache, slight pain in the right lower quadrant, and painful right breast. The last regular period had been January 2. Examination revealed an irregularly enlarged uterus about

showed pregnancy hypertrophy. My diagnosis was intra-uterine pregnancy with the probability of a small fibroid in the right horn. The Friedman test was positive. The patient was justly confused by three different diagnoses. She could not reconcile the diagnosis of intra-uterine pregnancy and the abortion which she believed she had obtained in February. However, no tissue had been observed to have been passed, and the slight amount of bleeding hardly warranted the assumption that the abortion had been accomplished.

In order to present additional and more positive evidence of the true pelvic condition, a transabdominal pneumoperitoneum was induced the following day at Michael Reese Hospital. Films made in the partial knee-chest position revealed the typical picture of an intra-uterine pregnancy of about 10 weeks' duration (Fig 1). No adnexal mass or fibroid was to be seen (Both conditions could have been readily visualized, if present). The patient was advised to report back for prenatal care. She subsequently visited a professional

abortionist and the intra-uterine pregnancy was removed. She returned for examination three months later, when a normal genital status was found.

Case 2 Mrs V L, age 23, married

the left of a normal uterus and right adnexæ (Fig 2)

The patient was treated expectantly. Menstruation occurred on April 2 and check-up examination on April 9 revealed

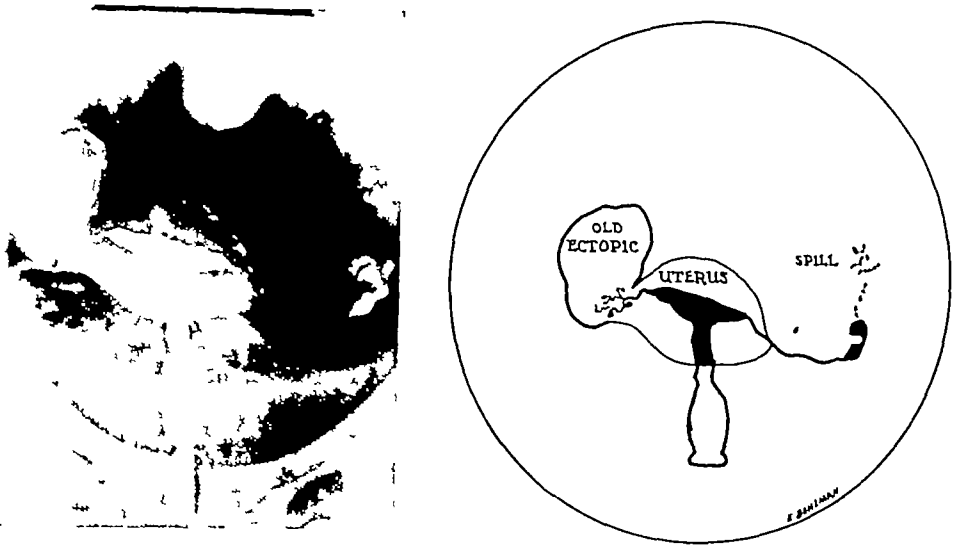


Fig 3 Transabdominal pneumoperitoneum combined with lipiodol instillation Old ectopic pregnancy

14 months, para 0. Menses began at 15, every 30 days, 5-6 days' duration, moderate, slight dysmenorrhea first and second day. Last period had occurred on Feb 6, 1929. When first seen, on March 25, 1929, patient complained that for two weeks she had suffered severe pain and profuse bleeding. At that time she was two weeks overdue and, when seen by the family doctor, was thought to have been pregnant. She was free from pain after this until one week before consultation, when abdominal pains recurred and were present when the patient presented herself for examination.

Bimanual examination revealed an apparently normal-sized uterus, soft, erect. The cervix was soft and the external os was closed. The right adnexæ were negative. There was a very soft and acutely tender swelling in the left adnexæ. Diagnosis rested between tubal pregnancy and corpus luteum cyst.

Transabdominal pneumoperitoneum was performed, the pelvic pneumogram revealing an unmistakably cystic ovary to

entirely negative pelvic findings, the cystic condition having entirely disappeared from the ovary. That corpus luteum cysts of the ovary may spontaneously disappear is well known to gynecologists. Not infrequently, women with similar conditions are operated upon and corpus luteum cysts are found instead of the expected ectopic pregnancy.

Case 3 Mrs E W, seen in January, 1931, gave a history of spontaneous abortion at home two months before and bleeding that had continued irregularly since then, accompanied by right pelvic pain. Upon examination, a tender right-sided egg-sized swelling was found. The uterus and left adnexæ were negative. She was informed that the mass was probably a tubal pregnancy and was advised to go into the hospital for operation. Because of economic stress, the patient did not return immediately, but presented herself six months later complaining of continued right-sided pain and irregular bleeding. She was scheduled for pneumoperitoneum

at the hospital, and an associate was delegated to the task. By misunderstanding what was desired, he instilled lipiodol for determining tubal patency and reported that the right tube failed to admit the

Difference in opinion is frequently encountered in cases such as those, with small fibroids associated with pelvic conditions, namely, chronic adnexitis or endometriomata. Patients are confused by

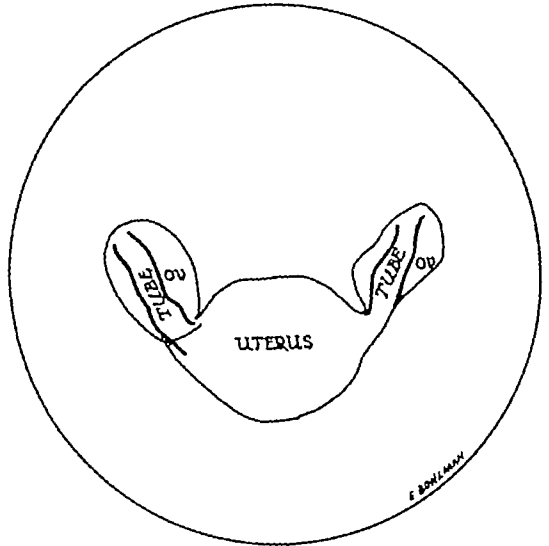


Fig 4 Transabdominal pneumoperitoneum Normal status

iodized oil. The procedure was then repeated by the author, a transabdominal pneumoperitoneum was induced combined with lipiodol instillation. The films revealed the pelvis status (Fig 3). The uterine cavity and the left tube were normal and the tube was patent. The uterus was normal in size and the right tube was enlarged to almost uterine size, oval in shape. It is clearly outlined by the pneumoperitoneum. The lipiodol entered the tubal isthmus and then dispersed into fine channels. I believe this dispersion of the iodized oil in the tube to be characteristic of certain tubal pregnancies in which blood clots fill the tube. The diagnosis from the films readily confirmed the previous one of tubal pregnancy. Operation was performed and a right tubal mole was removed. Recovery was uneventful.

A year later, the patient presented herself because of a two months' amenorrhea, nausea, and vomiting. She was found to be pregnant and was subsequently delivered normally at term.

conflicting opinions given, and usually welcome, as does also the doctor, some convincing evidence such as may be offered by a pneumograph. In my private practice and in the service at Michael Reese Hospital, it is chiefly in such cases in which differing opinions are offered that I employ diagnostic pneumoperitoneum, as I have learned that in this manner a correct diagnosis can be made without recourse to the exploratory operation. In some such instances, particularly in women suffering from pelvic pain and obese subjects in whom the bimanual examination does not reveal a definite pathologic condition, the film may show perfectly normal pelvic viscera (Fig 4) and thus obviate the necessity for any operation. On the other hand, the patient may have been ill advised in an instance in which there was real need for surgery as in the case which follows.

Case 4 Mrs F P, age 44, married 22 years, grav 11. Menses began at 12, irregular 6-8 weeks' intervals, five days' duration, moderate until 1934, when

periods became more profuse the first day and patient complained of pressure pain on rectum

Examination in October, 1934, revealed an apparently normal uterus. The cervix

left adnexal mass and evidence of adhesions were seen. The films demonstrated clearly that there was sufficient pathology in the pelvis to warrant surgical intervention.

In another group of patients, the gynecologist

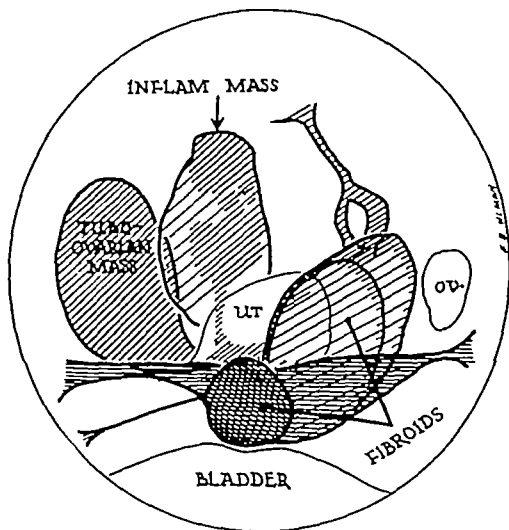


Fig 5 Transabdominal pneumoperitoneum Extensive pelvic pathology Uterine fibroids complicated by adnexal inflammation and adhesions

was scarred from previous repair and several small cysts were palpated on the cervix. Rectal examination was negative. On Feb 26, 1935, the patient returned because of rectal pain and pelvic discomfort. The uterus was found at this time to be enlarged, hard, and globular. Adnexal findings were indefinite, but there was more tenderness than previously. Specular examination revealed the same cervical and vaginal findings as previously. Hysterectomy was advised.

The patient decided to seek opinion elsewhere. At a university clinic, she was told by the senior attending physician that there was no need for surgery. She then consulted a colleague who advised pneumoperitoneal diagnosis after he also found definite pelvic pathology on bimanual examination. The films (Fig 5, by courtesy of Dr M L Leventhal) revealed pathology indeed! The uterus was irregularly enlarged, with an oval mass in the right horn having a dense border suggesting calcification. In addition, a dense

colologist may fail to find any pathologic conditions to account for the patient's symptoms—he may classify them as functional disturbances. Under such circumstances, we have at times been able to disclose by means of pneumoperitoneum, malformations and developmental or glandular alterations of the pelvic organs which explained the symptoms. In this connection, we recently published a series of cases in which bilateral polycystic ovaries were diagnosed, chiefly by means of pneumoperitoneum, in young women complaining of amenorrhea and sterility (4). The ovarian enlargements were not palpable in some instances but were clearly visualized on the pneumogram. The correct diagnosis by means of roentgenographic methods led to the successful surgical treatment and to the ultimate correction of a supposed *functional* derangement (Fig 6). After operation, menstruation became regular and fertility was restored in these patients.

In establishing the causative factors in

cases of sterility, it is often desirable not only to reveal patent tubes, either by gas or by iodized oil, but also to show whether there is any pathologic alteration in the uterus, in the ovaries, and whether there

leave with a resolve to utilize it when they return home

In addition to their value in clinical diagnosis, the films have proved to be a great asset in illustrating lectures By

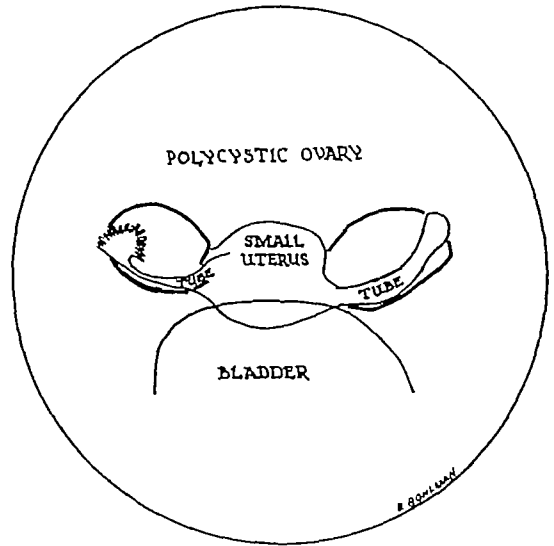


Fig 6 Transabdominal pneumoperitoneum Bilateral polycystic ovaries Single girl age 20 Never menstruated until after operation

are pelvic adhesions or other pelvic conditions I have thus frequently found pathologic conditions in addition to that discovered by palpation by employing pneumoperitoneum as a routine in my sterility investigations (5)

TEACHING VALUE

Michael Reese ex-internes have frequently written to me after leaving the hospital, expressing their regrets that they have no facilities for pelvic pneumoperitoneum in their present locations, and they have often cited cases wherein it might have been used to good advantage. My students are likewise impressed with the clarity with which the female pelvic organs can be shown on the film, and are puzzled that they do not get instruction and training in their schools in this field. Furthermore, visiting physicians express great surprise when shown the "beautiful films" obtained by pneumoroentgenography not having realized previously the method's immense diagnostic value. They

means of the pneumogram, we can demonstrate differences in size and shape of the uterus, abnormal doubling, the presence of fibroids—their number and location—often determining thereby whether conservative treatment (myomectomy) may or may not be employed. Ovarian tumors and cysts may be differentiated from each other and from other adnexal conditions. In two instances, I discovered *parovarian cysts* by means of the pneumogram, which diagnosis proved correct at operation. The presence of both ovaries in addition to a globular cyst led to the pre-operative diagnosis. By means of the combined method—iodized oil instillation and pneumoperitoneum—a maximum of information concerning the pelvic organs is obtained. The uterosalpingography reveals the *lumens* and pneumoroentgenography the *contours* of the uterus and adnexæ (6)

DANGERS

The fact that pneumoperitoneum has been used in Michael Reese Hospital for

more than a decade by all members of the gynecologic staff, many times by house physicians, and occasionally by non-staff visiting physicians, without accidents, is adequate answer to the question of danger. In occasional instances, the method has been abandoned short of completion because of discomfort, nervousness, or apprehension on the part of the patient. When no contra-indication exists, the transuterine route is used for inflation, when it becomes a mere prolongation of the patency test. Otherwise, transabdominal puncture is made, the technic for this procedure having been previously published (7). There has never been a bowel or blood vessel injury as a result of puncture in our hands. Gas (CO_2) injected into the adherent omentum has been occasionally observed, appearing at operation as emphysema of the omentum, but no ill effects resulted therefrom.

The pain occasioned by peritoneal puncture and distention is transient and is minimized by preliminary medication with morphine and scopolamine. In some instances, the CO_2 does not absorb as rapidly as one would expect, resulting in shoulder pain and upper abdominal distress which may exist for a few days. However, with pure CO_2 , absorption should be complete within a few hours. By hospitalizing the patient for 24 hours, as is my routine, the discomfort is reduced to a negligible minimum. When undue pressure is used in instilling iodized oil into the uterus, injection of the uterine sinuses and pelvic veins occasionally results. This condition has been reported in the literature and usually occurs in cases of tubal obstruction (6). While it is considered to be an error in technic, nevertheless this complication does not result in harm to the patient.

COMMENT

In my opinion, pelvic roentgenography has proven to be a distinct step forward in gynecologic diagnosis. While uterotubography has been more widely adopted in the study of sterility because of its graphic portrayal of tubal patency or obstruction, pneumoperitoneum is of far greater value in the majority of gynecologic conditions which present difficulties in diagnosis. Furthermore, the combined method offers all of the advantages of both technics. The procedure, while time-consuming, is not difficult or dangerous, providing that intelligence and care be employed. Every x-ray department should be properly equipped with a suitable table to take pelvic roentgenograms after pneumoperitoneum, and gynecologists should be familiar with the technic, so that, in co-operation with the roentgenologist, they can avail themselves of this truly valuable method of diagnosis. Pneumo-roentgenography serves as one outstanding method of accurate diagnosis in obscure surgical conditions in the pelvis; contrarily, it may reveal normal pelvic viscera in the presence of symptoms referable to the pelvis, thus obviating the necessity for exploratory operations.

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A COMPARISON OF THE USE OF TRANSUTERINE INSUFFLATION WITH CARBON DIOXIDE AND ROENTGENOGRAMS TAKEN AFTER THE INJECTION OF IODIZED OIL¹

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TRANSUTERINE insufflation of the fallopian tubes with carbon dioxide has been employed in gynecologic diagnosis since 1920, when Rubin published his technic and observations. Sicard and Forestier, in 1925, reported the injection of a solution of iodine in oil into the uterus and tubes, followed by roentgenograms, in order to visualize these viscera. Stein and others have combined the two procedures with the idea of securing additional information because of greater contrast in the roentgenograms. A considerable literature has accumulated concerning both methods of investigation and concerning combination of the two methods.

Insufflation is a procedure which can be employed safely and satisfactorily in the office. In performing more than 2,000 of these tests no significant sequelæ have occurred. Properly performed, insufflation will give accurate information as to the patency or non-patency of the oviducts

of the tube. In addition, the relative size of the lumen of the fallopian tube can be estimated by the amount of pressure in millimeters of mercury necessary to force the gas through the tube. Thus, a tube is said to be patent to normal pressure when this pressure does not exceed 100 or at the most 120 mm of mercury (Fig 1-A), and to be stenosed or relatively obstructed when the gas passes at pressures of from 120 to 200 mm of mercury. The highest mercury pressure that should be employed is 200 mm. It has been shown that if this pressure does not force the gas through the lumen of the tube, a diagnosis of non-patency may be made (Fig 1-B).

The determination of patency of the tubes to insufflation with carbon dioxide is made by (1) reading the pressure in millimeters of mercury at which the gas passes through the uterus and tubes, making the reading either directly on the manometer scale or on a kymograph connected to the

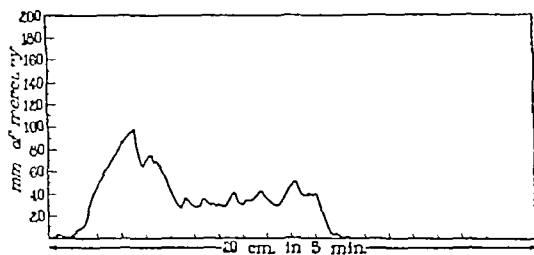


Fig 1-A

Fig 1-A Normal patency of the tubes. A kymographic tracing obtained during the transuterine insufflation of normal fallopian tubes that are patent to normal pressure as expressed in millimeters of mercury.

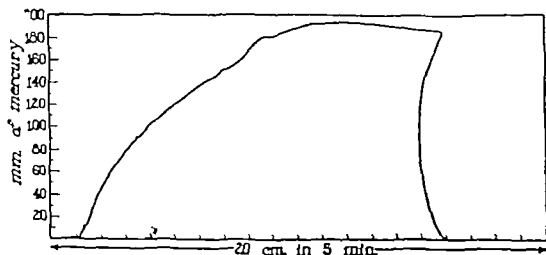


Fig 1-B

Fig 1-B Non patent tubes. A kymographic tracing obtained during the transuterine insufflation of fallopian tubes that are not patent to a pressure of 200 mm of mercury.

The normal tube will respond to the passage of gas by muscular activity which is transmitted to the kymograph as waves or variations in the pressure necessary to cause the passage of gas through the lumen

manometer, (2) auscultation over the lower part of the abdomen during performance of the insufflation at which time a definite bubbling sound can be heard as the gas passes through the tubes, (3) the practically invariable elicitation of pain in the shoulder when the patient resumes the upright position after introduction of between 200 and 300 c.c. of gas, this is attributable

¹ Read before the Radiological Society of North America at the Twenty second Annual Meeting at Cincinnati, Nov. 30-Dec. 4, 1936.

to subphrenic pneumoperitoneum, (4) making roentgenograms which may demonstrate this pneumoperitoneum

the uterine portion of the fallopian tube may influence the passage of gas or of any medium in the absence of pathologic



Fig 2-A

Fig 2 B

Fig 2-A Normal patency of the tubes The roentgenogram was taken after the intra uterine injection of iodized oil which immediately followed the insufflation represented in Figure 1-A Both tubes are filled with the contrast medium

Fig 2-B Normal patency of the tubes This roentgenogram was taken of the same patient represented in Figure 2-A, ten minutes after that roentgenogram The iodized oil has disseminated throughout the pelvic portion of the peritoneal cavity

The determinations of patency of the tubes in roentgenograms, taken after the injection of iodized oil is based on the demonstration of tubal filling, with spilling of the medium into the peritoneal cavity (Figs 2-A and 2-B) This may be observed under the fluoroscope at the time of the injection or in roentgenograms taken at intervals following the injection When the correct interpretation is in doubt, it is well to make further roentgenographic studies a few hours after the patient has been up and about At this time, oil which has passed through the tube will be disseminated throughout the pelvic peritoneal cavity This study is based, primarily, on 600 patients All received iodized oil and three gave evidence of pelvic inflammation following the injection These were all instances of chronic salpingitis with tubal occlusion in which oil did not reach the peritoneal cavity

It has been demonstrated repeatedly that the activity of the muscle surrounding

change This activity of the muscle may lead to erroneous diagnoses of stenosis or non-patency, regardless of the medium employed Consequently, it is generally considered best to repeat either or both examinations if the first test fails to reveal the passage of carbon dioxide or of iodized oil The second examination preferably should be preceded by the hypodermic administration of one-fourth grain (0.016 gm) of morphine and one-one hundred and fiftieth grain (0.0004 gm) of atropine By this means the muscular activity of the uterus is inhibited and no physiologic impediment should exist to the passage of the injection medium

The technic for the performance of these two tests need not be outlined except to say that a uniform method of procedure was used in the performance of the tests throughout the series

Following introduction of the method in which a stable solution of iodine in oil is used, at the Clinic we employed transuter-

TABLE I—COMPARISON OF DIAGNOSES MADE FROM ROENTGENOGRAMS FOLLOWING INJECTION OF IODIZED OIL AND FROM TRANSUTERINE INSUFFLATION OF FALLOPIAN TUBES WITH CARBON DIOXIDE

	Diagnoses Made from Roentgenograms		Diagnoses Made from Transuterine Insufflation	
	Patients	Percentage of 600	Patients	Percentage of 600
Normal tubal patency	324	54	312	52
Chronic salpingitis with tubal patency	81	13.5	126	21
Total tubal patency	405	67.5	438	73
Chronic salpingitis with occlusion at uterine cornua	113			
Chronic salpingitis with occlusion beyond uterine cornua	82			
Total non-patent tubes	195	32.5	162	27
Total	600		600	

ine insufflation with carbon dioxide and an injection of iodized oil in practically every case in which there was a question as to the permeability of the fallopian tubes. The insufflation was performed first and was followed immediately by injection of the iodized oil. These procedures were carried out on the 600 patients in order to determine the relative accuracy of the two procedures in our hands.

The diagnoses in this group of cases, according to the results of the two tests, are shown in Table I.

It would seem from these figures that the diagnosis of normal tubal patency is made with approximately the same accuracy by both methods of investigation, there being a difference of only 2 per cent in this group. It is interesting to note that nearly half of the women who complained of sterility gave evidence of previous tubal disease.

The diagnosis of chronic salpingitis with tubal patency was made by means of transuterine tubal insufflation in 126 cases (21 per cent) and is based on the need of pressures of between 120 and 200 mm. of mercury to cause the carbon dioxide to pass through the tubes and on a reduction of the number and extent of the fluctuations in pressure that are observed as the gas is passing through the tubes. The kymographic tracing in such a case is represented in Figure 3. The diagnosis of chronic salpingitis with patency of the tubal lumen, made from roentgenograms

after injection of iodized oil, has been based on delayed emptying of the tube, evidence of retention of oil in the fimbriated extremity, with subsequent leakage of the oil into the peritoneal cavity, and clear-cut, wire-like tubal shadow with spilling into the peritoneal cavity, marked tortuosity of the tube and evidence of abnormal position of the tube (Figs 4-A and 4-B, and 5). I have not been certain in all cases that a diagnosis of chronic salpingitis with patency of the tubal lumen was to be made from the roentgenographic evidence alone, for the roentgenogram may have failed to show sufficient signs to indicate such a diagnosis. A correlation of clinical history, physical examination, and results of insufflation seem necessary for complete diagnosis in many cases. The difference in the number of cases in which this diagnosis was made by the two methods is appreciable (45, 7.5 per cent of 600). This difference seems attributable to the fact that in the group of patients with diseased tubes and patent lumens, insufflation will show the signs of tubal disease more frequently than will roentgenograms. Stenosis of high grade might be found and the patient subsequently might have pneumoperitoneum with pain in the shoulder, but from the roentgenogram it would be impossible to demonstrate oil free in the peritoneal cavity.

The diagnosis of occlusion of the fallopian tubes, made from roentgenograms

to subphrenic pneumoperitoneum, (4) making roentgenograms which may demonstrate this pneumoperitoneum

the uterine portion of the fallopian tube may influence the passage of gas or of any medium in the absence of pathologic



Fig 2-A

Fig 2-A Normal patency of the tubes. The roentgenogram was taken after the intra-uterine injection of iodized oil which immediately followed the insufflation represented in Figure 1-A. Both tubes are filled with the contrast medium.



Fig 2-B

Fig 2-B Normal patency of the tubes. This roentgenogram was taken of the same patient represented in Figure 2-A ten minutes after that roentgenogram. The iodized oil has disseminated throughout the pelvic portion of the peritoneal cavity.

The determinations of patency of the tubes in roentgenograms, taken after the injection of iodized oil is based on the demonstration of tubal filling, with spilling of the medium into the peritoneal cavity (Figs 2-A and 2-B). This may be observed under the fluoroscope at the time of the injection or in roentgenograms taken at intervals following the injection. When the correct interpretation is in doubt, it is well to make further roentgenographic studies a few hours after the patient has been up and about. At this time, oil which has passed through the tube will be disseminated throughout the pelvic peritoneal cavity. This study is based, primarily, on 600 patients. All received iodized oil and three gave evidence of pelvic inflammation following the injection. These were all instances of chronic salpingitis with tubal occlusion in which oil did not reach the peritoneal cavity.

It has been demonstrated repeatedly that the activity of the muscle surrounding

change. This activity of the muscle may lead to erroneous diagnoses of stenosis or non-patency, regardless of the medium employed. Consequently, it is generally considered best to repeat either or both examinations if the first test fails to reveal the passage of carbon dioxide or of iodized oil. The second examination preferably should be preceded by the hypodermic administration of one-fourth grain (0.016 gm) of morphine and one-one hundred and fiftieth grain (0.0004 gm) of atropine. By this means the muscular activity of the uterus is inhibited and no physiologic impediment should exist to the passage of the injection medium.

The technic for the performance of these two tests need not be outlined except to say that a uniform method of procedure was used in the performance of the tests throughout the series.

Following introduction of the method in which a stable solution of iodine in oil is used, at the Clinic we employed transuter-

TABLE II—RESULTS OF REPEATED EXAMINATIONS

	Cases
Repeated investigations made	92
Initial diagnosis of non-patent tubes confirmed	54
Initial diagnosis of chronic salpingitis with patency confirmed	9
Initial diagnosis of non-patent tubes changed to one of normal patency	19
Initial diagnosis of non-patent tubes changed to one of chronic salpingitis and patency	10

sults of these repeated examinations are presented in Table II

The present procedure at the Clinic is first to perform insufflation in all cases in which there is a complaint of sterility, and if normal patency is determined but the patient does not present evidence of pathologic change in the pelvic viscera on the performance of careful pelvic examination, examination with iodized oil is not considered necessary. However, if non-patency

is diagnosed, or if the tubes are patent to high pressures, or if palpable adnexal disease is evident, a second examination is performed, using iodized oil. Presuming that a uniform and careful technic is employed there is little to choose between these two methods of diagnosis in the case in which the tubes are normal. When chronic tubal disease with patent tubes exists I believe that transuterine insufflation and injection of iodized oil both should be performed.

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Fig 8-A



Fig 8 B

Fig 8-A Muscular resistance to injection of media. This roentgenogram was taken after an insufflation had resulted in a kymographic tracing similar to that shown in Figure 1-B indicating non patent tubes. The uterus is filled with the medium but no oil has reached the lumen of the tubes or the peritoneal cavity.

Fig 8-B Muscular resistance to the injection of media. A roentgenogram made 10 minutes later than that represented in Figure 8-A. It shows the uterus to be in the process of emptying but no oil is observed in the tubes or peritoneal cavity.

aminations gave results that indicated chronic salpingitis with patency. Thus, there were 29 cases in which acceptance of

the results of the first examination would have resulted in error in diagnosis as determined by repeated investigation. Re-



Fig 9 A



Fig 9 B

Fig 9-A Muscular resistance to the injection of media. This roentgenogram was made four days later of the same patient as the one represented in Figures 8-A and B. One fourth of morphine and $\frac{1}{100}$ grain of atropine had been administered hypodermically 45 minutes previous to the examination. The uterus and tubes are filled with the oil.

Fig 9-B Muscular resistance to the injection of media. In this roentgenogram the tubes are partially empty and oil can be seen to be free in the peritoneal cavity. The patient was the same as the one represented in Figures 8-A and B and 9-A.



Fig 1

Fig 1 Pregnancy of less than 93 days Diagnosis made by Dr Joseph F Elward Both lateral margins of the chest and also the spinal column are visible as indicated by arrows



Fig 2

Fig 2 Pregnancy of less than 112 days diagnosed by Dr Joseph F Elward

Other methods of diagnosing early pregnancy are either attended with certain dangers or are subject to error This method of diagnosis is safe and positive Films have not been retouched

Pregnancy produces a laxity of the pelvic joints, permitting greater mobility of the iliac bones on a transverse axis through the sacrum We now consider a widening of the pubic symphysis as depicted by the X-ray, to be one of the physiologic changes attending late pregnancy Some observers believe that the widening designates absorption rather than separation of bone I am inclined to think that the effect is produced by a softening and thickening of the ligaments, probably a change which occurs in the birth canal preparatory to labor

It is surprising to note that although the importance of the configuration of the bony pelvis in relation to the successful outcome of labor was emphasized as early as 1572 by Arantius (5), it was not until recently that attention was called to the contour of the inlet, with its effect upon engagement of the fetal skull, as well as pelvic architecture and its effect upon the mechanism of labor The knowledge furnished by roentgenography has enabled the expression of opinion as to what actually occurs during labor, and as to the tenability of the head and fast text book

theories which we were taught Those who studied medicine prior to a few years ago, are now surprised to learn that the pelvic inlet is not necessarily shaped like a flat heart *The normal variations* which we recognize in the contour of this plane, I should like to divide into two types First, those that may be discerned by even a layman, second, the type less easily detected, but of interest to the trained obstetrician In the first class may be placed any inlet with a marked departure from the normal contour, such as the four parent types described by Caldwell, Moloy, and D'Esopo (6) (Fig 3) In the anthropoid type (ape), engagement occurs with the longitudinal suture in the anteroposterior diameter, usually as an occipitoposterior In the platypelloid type (flat), engagement is expected with the longitudinal suture in the transverse diameter of the inlet In the gynecoid type (female), the longitudinal suture lies in one of the oblique diameters In the android pelvis (male), engagement would have a tendency to occur in the transverse diameter, but the architecture below the brim is such as to favor the occurrence of the mechanism of

ROENTGENOGRAPHY IN OBSTETRICS¹

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ROENTGEN could neither have visualized the magnitude of his discovery nor the perfection of technic which was to follow. Its applications have become infinitely numerous and conveniently yield positive information, in obstetrics alone, to say nothing of the dependence of the other branches of medicine upon this specialty.

According to Orley (1), the first radiography of the pelvis was performed by Varnier and Chappius in 1896, on the cadaver, and required an exposure of three hours. In 1897, Professor Budin exhibited a radiograph of a Naegele pelvis, the exposure time was 45 minutes. Our expectations, constantly becoming more demanding, have resulted in the production of sharp films with a minimum time of exposure.

APPLICATION TO CONDITIONS PARTICULARLY AFFECTING THE MOTHER

With the aid of pneumoperitoneum, Peterson (2) has diagnosed pregnancy at six weeks. In this manner, the shadow of the enlarged uterus may be made visible. If it were not for the hazard of abortion, the diagnosis could be made at a much earlier date using intra-uterine opaque media, the embryo produces a filling defect of the uterus. Incidentally, since the point of nidation predetermines the place of development of the placenta, the future site of that organ can be ascertained. Bartholomew, Sale, and Calloway (3) in a systematic study, have obtained positive evidence of the fetal skeleton in one-third of their cases at five months, one-half at six months, and almost constantly, there-

after. A positive roentgenogram is the most confirmatory evidence of pregnancy (Figs 1 and 2). Because the Aschheim-Zondek test is positive in 98 per cent of cases, and is not attended with any risk, it should supersede x-ray diagnosis in the early weeks. Extra-uterine pregnancy may be diagnosed even after the fourth month, by injecting the uterus with lipiodol. During normal pregnancy the uterine cavity is obliterated at this time. However, one should realize that decision to employ this procedure, in any case, must follow great deliberation, for the outcome may be unfortunate should the embryo be located in the uterus.

Effort to locate the placental site, especially in cases in which the possibility of placenta praevia or ablatio placenta presents itself, may be enhanced by the flat film in many cases, and by amniography in practically all cases. The flat film shows the presenting part to be displaced over the pelvic brim, because of interference of the bulk of the placenta. Following the injection of strontium iodide, thorotrast, or uroselectan through the abdominal wall into the uterine cavity, amniograms taken in the anteroposterior and lateral positions should outline the placenta as well as the umbilical cord and fetal parts, in male babies the genital organs may be revealed, thus diagnosing the sex. Amniography should not be resorted to unless one is ready to welcome the onset of labor, which is reported as a natural sequence in a fair percentage of cases. The drug itself seems to have no harmful effect and is rapidly eliminated. Titus (4) suggests that with the injection of 20 c c of sodium iodide into the bladder, the roentgenograms will usually show a filling defect, or a contrast shadow of the placenta.

¹ Presented by invitation before the Radiological Society of North America at the Twenty second Annual Meeting at Cincinnati Nov 30-Dec 4 1936

certain that the inlet and film are parallel, or the use of the precision stereoscope, should reveal the true configuration of the inlet. No case of fracture of the pelvis in any female up to the age of the menopause should be discharged without such a study, for there may result certain interference with the function of childbearing. Neglect to do this may cause embarrassment.

Again I wish to stress that the shape of the brim and the architecture of the true pelvis, as well as the pelvic outlet, have a definite influence upon the mechanism of labor. One of the fascinations of such study is that no man can predict what the radiogram will reveal.

From the standpoint of mechanisms, the obstetrician must consider pelvic inclination, or the angulation of the plane of the inlet toward the horizon. Recently Garnett and I (7) have directed attention to the significance of faulty inclination as a cause of dystocia, even in pelvises of normal size. Faulty inclination usually exists in patients possessing the dystocia dystrophia type of syndrome; they are short stubby individuals with high vertical symphysis and heavy bony skeleton. We have shown that the roentgen ray in the lateral view affords absolute knowledge of this condition. Furthermore, I (7) have found that pelvic inclination varies in all women and that the average is more favorable than has been generally recognized. Instead of the inlet making an angle of 30 degrees with the horizon in the recumbent posture, it makes an angle of 42 degrees, thus approaching a perpendicular to the longitudinal axis of the fetus and the forces of expulsion, and favoring entrance of the presenting part into the brim (Fig 5).

No definite relationship exists between the true and external conjugate diameters, for the thickness of bones varies in different individuals. It is possible for two women to have equal external conjugates, while their true conjugates may vary as much as three or four cm in length. The roentgenogram, of course, may reveal such facts.

Matthews (28) has suggested other uses



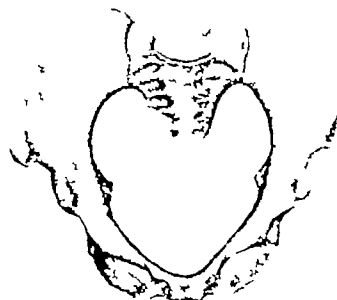
Fig 4 The plane of the superior strait in a patient that had had poliomyelitis in childhood. She is unable to walk and although this pelvis is unusually small she has had two babies normally. Film was parallel to inlet, by author's technic. In an ordinary flat film the contour of this inlet was overlooked. Fig 15 A is a lateral view of this patient. T C checks in both films. Length of true conjugate as calculated with author's inclinometer was 9.4 cm.

of the x-ray, such as diagnosis of bony tumors, healing after pubiotomy, differential diagnosis of fibroid tumors or myomas with or without pregnancy, ovarian cysts and dermoids, also in pseudocyesis. Reinberger and Russell (8) claim to have seen the contraction ring in several cases of dystocia, I have not had such an experience. They advise the study of dystocia by anteroposterior and lateral films, and they believe that they can early diagnose gas bacillus infection, when the film discloses the presence of gas in the uterus.

Since focal infections seem to influence the incidence of toxemias of pregnancy, I might mention the customary use of the x-ray in locating such foci.

Roentgenographic studies of the urinary tract are of value in observing the physiologic changes incident to pregnancy, as well as the abnormalities, such as kinking of the

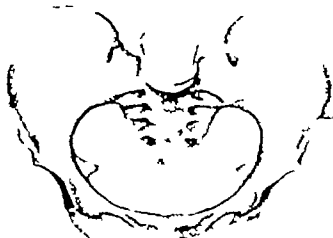
persistent occipitoposterior In the second class would belong the mixed types of assimilation pelvis (four sacral vertebræ) and such cases as split pelvis and absence



ANTHROPOID TYPE



GYNECOID TYPE



(PLATYPELLOID) TYPE



TRUE ANDROID TYPE

Fig 3 The four parent types of pelvis as described by Caldwell Moloy, and D Esopo Even a layman can detect the difference in the inlet contours Since adaptation is an important factor in engagement and resulting mechanism, the shape of the inlet plays an important part

Most pelvis show a blending of types and differences in contour may be detected only by the trained eye (Caldwell Moloy and D'Esopo in Amer Jour of Obst and Gyn, C V Mosby Co, Publishers)

pelvis, by far the most common, which are described by the same authors They have also described the true pelvis and outlet which are usually associated with the four parent types, information that has definite bearing upon the mechanisms of labor

Abnormal variations in the contour and architecture of the female pelvis may be conveniently classified into the congenital, acquired, and traumatic Congenital abnormalities are the Roberts' pelvis (absence of sacral alæ), Naegle pelvis (absence or shortening of one ala), the high assimilation pelvis (six sacral vertebræ), the low

of pubic or ischial ramæ, excellent examples of which have recently been called to my attention at the Johns Hopkins clinic The last two cases were discovered accidentally during routine pelvimetric study Pelvic deformities may be acquired from rachitis, poliomyelitis (Fig 4), tuberculosis, osteomalacia, and hip and joint diseases Marked asymmetry often follows fracture of the pelvis or poor results from a fractured femur in childhood The ordinary flat plate does not reveal discrepancies in pelvic symmetry, unless they are unusually marked (Fig 4) Careful scrutiny of the pelvis, using a technic in which we are

lithopedion, of course, may be easily visualized

In the last few years, the determination of the age of the fetus *in utero* has been approached from several viewpoints. This statement also applies to the weight of the fetus *in utero*.

Some authors judge the age from the appearance of epiphyseal ossification centers, the most important being the center for lower epiphysis of the femur which usually makes its appearance during the ninth month of pregnancy, and that for the upper epiphysis of the tibia which makes its appearance just prior to or just after birth. Shaw (11) states that this is not a reliable index, since in some cases the epiphysis of the femur is not present at birth, while the epiphysis of the tibia may be present at 37 weeks.

Thoms (5) states that the head usually lies with the occipitofrontal diameter in the transverse of the inlet, and therefore the x-ray in the supine position gives this measurement. From this he computes the biparietal diameter, the weight and length of the fetus. In a breech presentation it would be advisable to take the exposure in prone position in order to bring the fetal head closer to the film and also to prevent mobility.

Hodges (10) determines the occipitofrontal diameter and uses the graph of combined equations of Scammon and Calkins (12) to estimate the age in calendar months, or it may be estimated in weeks (Fig 6). In some instances there is a margin as great as eight weeks between the minimum and maximum age for a particular diameter, although the margin decreases somewhat when the lesser age groups are under consideration. I feel that one who is experienced can gauge by abdominal palpation the age of the fetus with as great a degree of accuracy. I am informed that Hodges makes similar determinations using the average circumference of the skull. The weight and viability may also be estimated from charts.

Occasionally one attempts to determine fetal maturity from the length of long bones

as obtained by the x-ray. In this respect I agree with Shaw (11), who feels that the procedure is rather futile because the distance and the plane of the long bones are unknown. The stereoscopic view, however, would enable more accurate estimation than a single exposure.

THE APPLICATION OF THE ROENTGEN RAY TO THE FETUS AFTER BIRTH

The time of appearance of the centers of ossification have been determined. None of the ossification centers are visible before the seventh week of intra-uterine life. The centers for the clavicles appear first at seven weeks. The one for the os calcis appears during the fifth month, the astragalus appears at the seventh month, and the cuboid at the ninth month. A complete radiographic table of the centers of ossification is given by Dorland and Hubeny (13), reference to which often can be relied upon to establish the age of the fetus.

Rachitic bone changes are a swelling of the outline of the cartilage, the epiphyseal center has a moth-eaten appearance, and the zone of temporary calcification is a thin line.

In syphilis there is an osteochondritis, with absence of a sharply marked zone of calcification between the cartilage and the growing bone. These changes, according to Williams (14), are most readily recognized at the lower end of the femur and lower ends of the tibia and radius.

Proof of extra-uterine life may be obtained from exposures of the fetal chest, which show whether the lungs have been expanded. Atelectasis may be diagnosed also.

Fractures, dislocations, and other skeletal defects may be recognized.

Visceral anomalies, especially of the intestinal tract, may be observed after suitable introduction of opaque media.

PELVIMETRY AND CEPHALOMETRY

As far back as 1896, Varnier and Pinard (1), working at the Baudeloque Clinic in Paris, estimated the various inlet diameters of pelvis by comparing the obtained

ureters and dilatation of the ureters and pelvis Hayes (9) has found that such

not uncommonly diagnosed, because the large skull is revealed, and occasionally

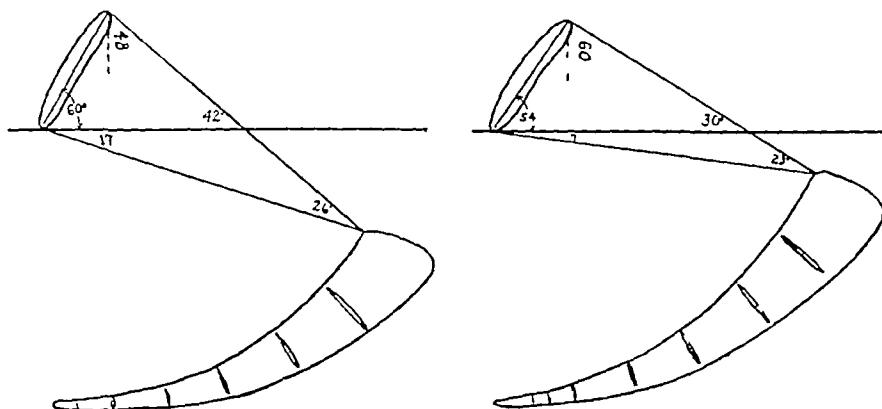


Fig 5 In a study made in a series of living women, I have found the average inclination of the pelvis to be 42 degrees in the recumbent posture Formerly it was presumed to be 30 degrees As the plane of the inlet tends to become perpendicular to the spinal column, engagement of the presenting part is facilitated (Garnett and Jacobs in Amer Jour Obst and Gyn C V Mosby Co Publishers)

conditions are commonly observed in the toxemias of pregnancy, and he believes that relief from the resulting urinary back pressure results in rapid recovery

THE DETERMINATION OF FACTORS CONCERNING THE FETUS BEFORE BIRTH

During late pregnancy the obstetrician is concerned with the presentation of the fetus or the relationship of its long axis to that of the mother In all cases in which doubt exists, radiography immediately furnishes such information

Variety, which is defined as the relationship of an arbitrarily chosen point on the presenting part to the right and left and anterior and posterior portions of the mother's pelvis, is determined by obtaining anteroposterior and lateral views, then associating the two films The flat stereoscopic view should give similar information

Absolute knowledge of multiple pregnancy and position of the babies affords the obstetrician the requisite sense of security Both an anteroposterior and a lateral view are usually advisable

Occasionally, monstrosities are detected accidentally during the course of roentgenologic examination At other times the roentgenogram is requested because of abnormal clinical findings Hydrocephalus is

irregularities in the contour of the skull signify the enlarged fontanels If other anomalies may be discerned, then more especially, should an amniogram be taken

Although death *in utero* does not warrant operative intervention unless certain clinical symptoms and signs are present, one prefers to be in possession of such knowledge as early as possible In my own experience, definite roentgenological evidence of fetal death is noted as a late change Schnitker, Hodges, and Whitacre (10) have expressed similar conclusions In their study, overlapping of fetal skull bones (Spalding's sign) was noted in only 25 per cent of dead babies, they warn that this phenomenon might have been present in a live baby if the patient had been in labor and that in hydramnios overlapping will probably not occur Angulation of the spine, although found in 50 per cent of their dead babies, was also found in many live babies, in these cases they wisely resort to mathematical probabilities and determine the age of the fetus as compared to the duration of pregnancy Collapse of the thoracic cage as described by Matthews (28) does not occur with any regular frequency Decalcification has been described as evidence of fetal death, but neither is this sign well warranted A

lithopedion, of course, may be easily visualized

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PELVIMETRY AND CEPHALOMETRY

As far back as 1896, Varnier and Pinard (1), working at the Baudeloque Clinic in Paris, estimated the various inlet diameters of pelvis by comparing the obtained

roentgenograms with those of dried pelvis placed in the same position

Albert (1), in 1897, was the first to understand the importance of having the inle

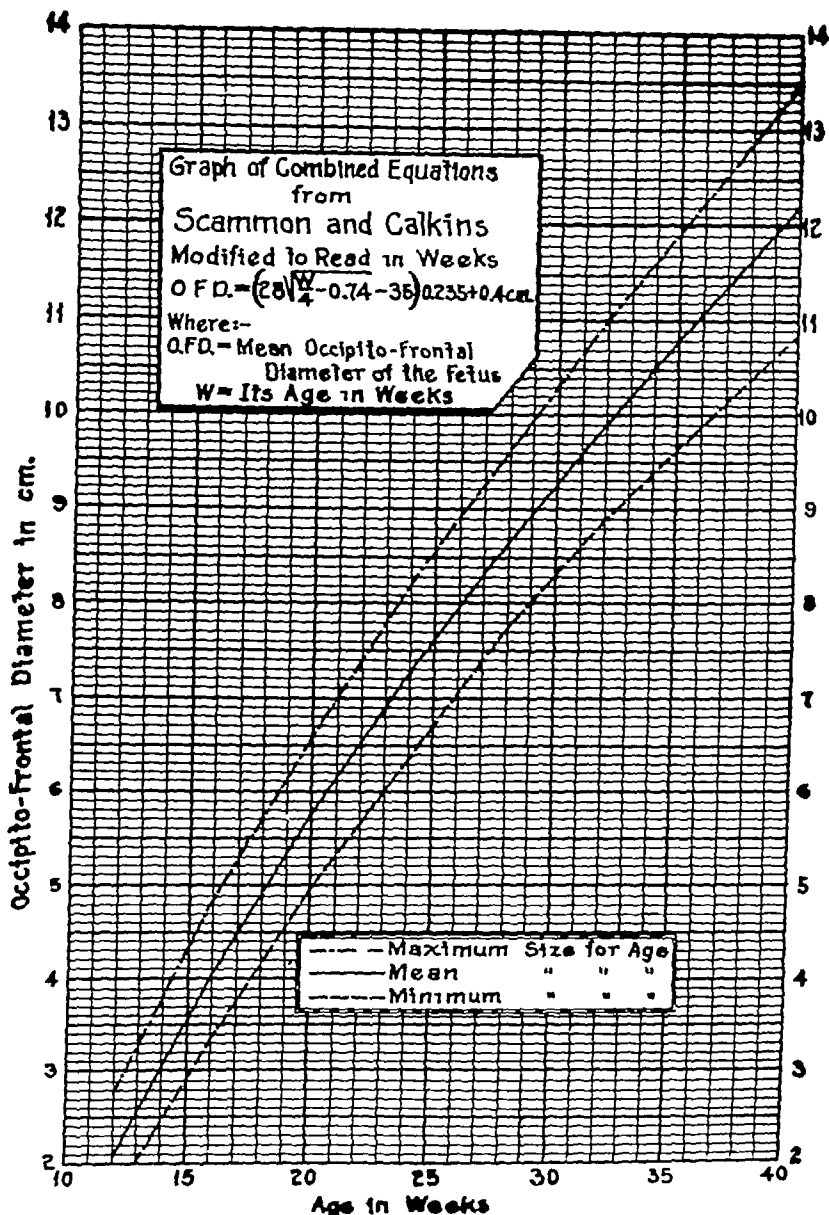


Fig 6 Graph showing age of fetus for any given occipitofrontal diameter For any length note the wide margin of error (Scammon and Calkins)

In 1900, Varnier (1), in an effort to overcome distortion, placed the tube five meters away from the patient. It is difficult to imagine that he had any success, for in spite of evolutionary improvements as late as 1929, similar efforts made by Elward and myself at distances of only six feet were unsuccessful.

parallel to the film, and several of the standard techniques, including my own, are based upon that principle.

Time will not permit a discussion of all the contributions made to roentgenographic pelvimetry. In this country pioneer work has been done by Thoms and it was through his continued effort that others

became interested in a subject that previously appeared to be very unattractive

It shall be my purpose to describe very briefly some of the technics which are being popularized to-day and to comment upon the relative merits of each. Then I should like to proceed with a more detailed description of the procedures evolving from the use of the obstetric inclinometer (15) which I had devised and published in 1928, a technic which has served me very satisfactorily

Thoms (16) places the patient on the usual x-ray table, in a semi-sitting posture, in an effort to cause the inlet to be parallel with the film. The tube is centered over the approximate middle of the inlet, this point being about two inches posterior to the upper border of the symphysis, exposure is then made. The distance of the tube to the film is noted. Then the distance of inlet to film is determined by locating certain external landmarks which are presumed to lie in the plane of the inlet, and measuring their height above the film.

The patient is then removed from the table and a thin lead plate, with perforations 1 cm apart throughout its surface, is placed in the position formerly occupied by the inlet. A flash exposure is made on the original film. The perforations appear as black dots on the developed film, and the distance between the individual dots is enlarged in the same proportion as the image of the inlet. Thus the antero-posterior and transverse diameters of the inlet are measured by counting the dots.

Thoms (5) presumes that the fetal head usually lies with the occipitofrontal diameter in the transverse, and I believe that in most instances this is true. Therefore, with the patient in the supine position, and using a technic similar to that just described, he obtains this measurement, which he claims is accurate. From this diameter he computes the biparietal diameter, and the weight and length (crown to heel measurement) of the fetus.

Comment—Since the true and external conjugates do not lie in the same plane, it is impossible to tell when the inlet is

parallel to the film in any of the "position technics." Experimenting with the bony pelvis, I (25) have shown that discrepancy of only five degrees between the inlet and film produces an error of 0.5 cm, an error as great as 1 cm could easily be encountered. In spite of my observations, I feel that this method has definite value.

The technic as to cephalometry is very simple, and were we sure of the absolute transverse position of the head in all cases, and were we able to measure the exact elevation of the mid-plane above the table, an accurate reading could be obtained. Cephalometry, by my own technic, is based upon similar assumptions, and so I have felt somewhat justified in stressing its importance. In some cases, no doubt, the determinations are of value, but there is too much room for error, and it would be unwise policy for one's judgment to be guided in all cases by such procedure.

Walton's (17) "position method" is very similar to that of Thoms, except that for measuring distortion he uses a correction chart instead of the lead grid with cm perforations. Such a "false centimeter scale" could be constructed for any fixed tube-film distance.

The flat surface of the head (occipitofrontal) is measured as by Thoms. With the patient in the supine position, and the film supported vertically on one side of the patient while the tube is directed from the opposite side toward the midpoint of the head, the biparietal diameter is determined.

Comment—We are not sure that the inlet is parallel to the film. The false centimeter chart is practical, time-saving, and ingenious. This method also has practical utility. My views regarding the technic of cephalometry are identical with those already expressed. I might add, incidentally, that I have tried taking lateral roentgenograms for pelvic measurements, with the patient in supine position, in the manner that Walton measures the biparietal diameter, but had little success.

Jarcho's (18) technic for both pelvimetry and cephalometry differs but very little

from those already described. In order to position the inlet, the patient is placed in almost a sitting position, with legs hanging downward over the edge of the table. He uses the perforated lead grid for measuring the distortion.

Comment—Advantages and disadvantages are similar to those previously mentioned. In centering the tube over the inlet, due to the sitting position, the rays must penetrate a rather long diameter of the fetus and uterus, this is not a desirable feature.

Ball (19) has approached the problem of cephalo-pelvic determinations from a unique point of view. He takes an anteroposterior and a lateral picture of the pelvis. With the pelvicephalometer which he has devised, he attempts to ascertain the volume of the fetal skull, and the volume capacity of the most common smaller pelvic diameters, namely, the true conjugate, and the distance between the ischial spines. His instrument, like a map tracer, records the circumference of the skull on both films, which are right-angle views, the mean of the two is the average circumference of a sphere. He next determines the height of the mid-plane of the skull above the film, which is easily noted on the lateral view. The indicator on the face of the instrument allows for correction due to variable distance of head over film and denotes the volume of the skull in milliliters.

The instrument then measures the length of the true conjugate diameter from a lateral view and the volume capacity of a sphere of that diameter, corrected for its distance above the film as observed on the anteroposterior view (from symphysis to trochanter), is recorded on the dial.

Similarly, the volume capacity of the bi-ischial spine diameter, as noted in the flat plate, and corrected for its distances over the film as observed on the lateral view, is recorded by the indicator on the instrument. Ball makes some allowance for the thickness of the scalp and moldability.

Comment—There are several factors which may be variable. One is not certain that the cephalic perimeters are those of perpendicular planes, thus permits of error in computation of skull volume. Images are larger than the objects which are x-rayed, therefore it is difficult to note accurately the distance of spines to film on the lateral view. An important correction factor in computing the volume capacity of the bi-ischial spine diameter. Likewise, there is a certain compressibility of the tissues over the great trochanter which would affect computation of volumetric capacity of the true conjugate. Regardless of whether linear or volumetric comparisons are made between the head and pelvis, it is always possible for the long diameter of a skull to engage or encounter the short diameter of a pelvic plane, resulting in dystocia. Were the head soft instead of bony, a shift in volume would occur, enabling its passage. It must be admitted, however, that the head, being more or less oval in shape, is more apt to accommodate itself to pelvic diameters, and that in most cases, volumetric comparisons if made at term, should prove of great value. I am not in favor of making a cephalo-pelvic study early in pregnancy, and then with the aid of a graph determining the rate of increase in volume of the skull, because graphs are merely averages, and in borderline cases the rule of averages may increase complications by interference with judgment.

Johnson's (20) method of stereoradiogenometry is based upon the principle of localization of foreign bodies. Orley (1) states that as early as 1901 Contremoulins used the Mackenzie-Davidson cross-thread method of localization of foreign bodies for pelvic measurements. He took two exposures on the same plate, each from a different point, and then reconstructed the course of the x-rays with threads, thus identifying the important points in space. Haenish, in 1912, built a special apparatus for this purpose, he took two exposures on two separate films and then transferred the

points from which measurements had to be made to a drawing. The drawing was then placed in the position occupied by the plate, and the two x-ray beams were reconstructed.

In 1929, Johnson (21) described his technique whereby two stereoscopic views are made with a given target-film distance and a fixed vertical shift of tube. One at a time, the films are placed in a view box and important identical landmarks localized on both films. His stereoroentgenometer consists of a view box directed upward (incorporated in a table top), with an upright rod of target to film height extending from the back of the table, and supporting a horizontal rod from which are suspended two strings at points which correspond to the target positions when the roentgenograms were taken. The two films, properly superimposed, are placed upon the glass surface of the view box, so that their center is directly beneath the midpoint between the origin of the two threads. To measure the true conjugate diameter hold the lower ends of the threads over the two points designating the sacral promontory, while an indicator is fixed in space at the intersection of the threads. Thus is established the location of the sacral promontory in space. Similarly, place an indicator at the intersection of the strings when their lower ends are applied to points designating the middle of the upper border of the symphysis. The exact position of the diameter then is shown by the two indicators in space, and the distance between them is the actual length of the true conjugate diameter. In like manner, Johnson states that he can measure any diameter of the pelvis, or any diameter of the fetal skull.

Comment—The technicalities here involved are accuracy in construction of apparatus and in procedure. There must be assurance that films are properly superimposed, that the midpoint between the tube shift is exactly over the center of films, and that all distances are definitely fixed. This impresses me as being an accurate technique of more practical value, and I shall make a comprehensive study of its application.

Clifford's (22) technique, except for slight individual modifications, is similar to that of Johnson.

Comment—He seems to be primarily interested in mensuration of the fetal skull in order to determine by reference to a compilation of similar data (in form of a graph), the maturity of the fetus or its viability, which information is of value in the conduct of certain cases complicated by toxemia, heart disease, vaginal bleeding, diabetes, pyelitis, etc. Because of his inability to visualize the promontory of the sacrum, his remarks are discrediting as to roentgenographic pelvimetry, and he regards the test of cephalo-pelvic disproportion as the old reliable test of labor a fact of some value.

Concerning his remarks on pelvimetry, I disagree, for it shall presently be shown that the important pelvic diameters can be measured by a simple and accurate technique. And at this point, I desire to state that in my opinion cephalic mensuration does not compare in practical importance with pelvic mensuration. The pelvis is fixed in both position and size in all its planes and dimensions. The head, on the contrary, is subject to changes in position as well as size, due to such factors as mobility of the fetus as a whole *in utero*, rotation of the skull on its vertical axis, or flexion and extension through its transverse axis, moldability, the shape and inclination of the inlet, interference from soft parts, etc.

There is less variation in contour and size of fetal skulls at term than there is in the configuration and size of the pelvis. So, although we desire and regard information as to the size of the head as being helpful in order to understand the mechanism and prognosis of labor, the information furnished by accurate pelvimetry is vastly more important. From the viewpoint of the pediatrician, much interesting research work may be done through cephalometry as regards the development of the fetus. From the practical point of view of the obstetrician, I must call attention to the wide margin of error, in estimating ma-

turity, in some cases being as great as several weeks, between estimated minimum parallax shift. Hodges has developed a formula for the correction of triangular dis

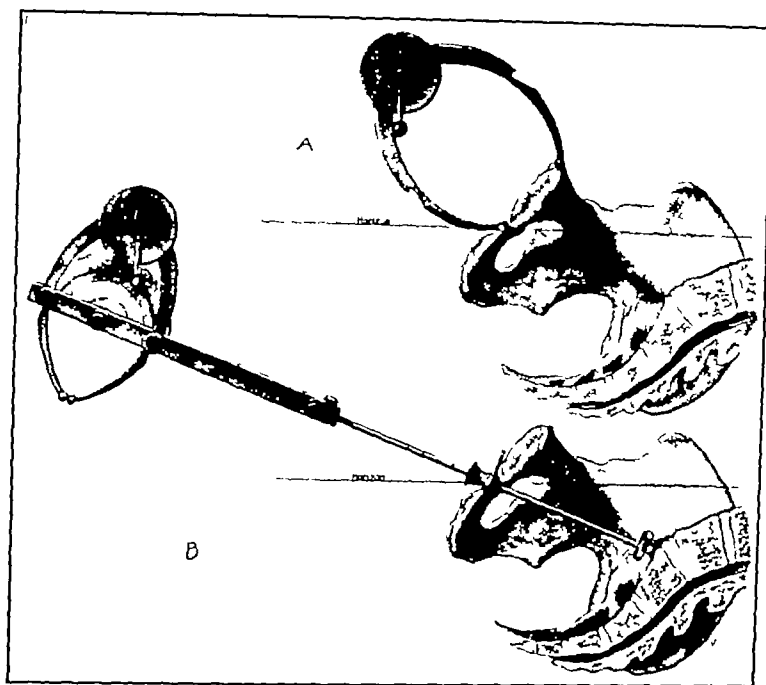


Fig 7 In upper drawing caliper of Bay Jacobs' Inclinator records height and inclination (angle with horizon) of symphysis. In lower drawing the length and inclination of diagonal conjugate are noted. (Jacobs in Amer Jour Obst and Gyn. C. V. Mosby Co. Publishers.)

and maximum age, and there may be a range of as much as 1,000 grams or more in weight. In some cases such information may be of great value, but it should not be emphasized to the point of exclusion of such a simple and practical procedure of reliable value, as mere palpation of the fundus by the hand of the experienced obstetrician. After all, the law of averages does not apply to individual cases.

Hodges' (10, 23) work does not differ materially from that of Johnson, although he is very precise in his technique. Stereoscopic views are taken, and using a map tracer, the occipitofrontal diameter of the skull is measured on each film and the average noted. The films are then accurately superimposed and placed in the view box, and the distance between the two identical points at each end of the diameter is noted. This is called the

tortion from which the correction factor may be derived where the parallax has been accurately measured, and the tube-film and tube-shift distances are known. The average occipitofrontal diameter, when multiplied by the average correction factor, yields the corrected diameter in the anteroposterior view. The age in weeks of the fetus may be determined by applying the calculated fetal head diameter to the graph of combined equations from Scammon and Calkins (12).

Hodges seems to be principally interested in cephalometry.

To measure the length of the true conjugate, the anteroposterior view is practically worthless because of the inability to accurately locate the endpoints of that pelvic diameter. Therefore, the lateral view is highly desirable for a determination of this pelvic diameter, and technique

similar to that used in cephalometry would be carried out on a stereoscopic pair of films. The length of the diameter on each film is measured and the average obtained. This average is multiplied by a correction factor derived from an average of the parallax shifts of the endpoints of that line, *i.e.*, the sacral promontory and the upper margin of the posterior surface of the symphysis pubis. It becomes necessary to average these two parallax shifts whenever the endpoints are not equidistant from the film.

Comment—This author is doing admirable work, but here again I believe that the importance of cephalometry is being overemphasized in relation to pelvimetry. Also in determining the age of fetus the margin between minimum and maximum age, for certain measurements, may be as great as eight weeks.

Hodges' published work differs from Johnson's in that the diameter is obtained by graphic means, instead of with the aid of the stereoroentgenometer.

Caldwell, Moloy, and D'Esopo (6) in their roentgenographic work stress particularly such factors as pelvic contours, disproportion, the mechanisms of labor and prognosis. From their work has evolved the excellent classification of pelvis which is being rapidly recognized as having definite value.

I believe that at present most of their work is being done with the patient in supine position, using a lumbosacral pad in order to overcome the disadvantage of markedly oblique inlet views.

Comment—These men have made a definite contribution to obstetrics, and the observations which they present will teach men to realize that the views previously stated in text books were very narrow, tending to limit the mental development and conception of medical students, as applied to obstetrics.

Author's Method—My own procedure of pelvimetric roentgenography as applied to borderline pelvis, may be divided into three stages

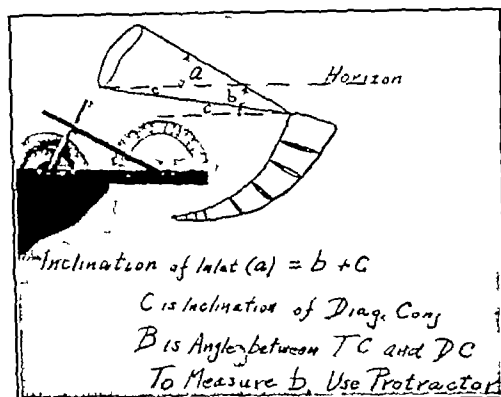


Fig 8 The diagram depicted is a reproduction of the calculator held in the hand. The scales of the calculator denote the three sides of the *obstetric triangle*, which is that formed by the symphysis, the diagonal conjugate and the true conjugate. Thus with the use of the calculator one may determine the inclination of the inlet (Jacobs in Southern Medical Journal)

- (1) Observations made with the author's obstetric inclinometer (15, 24)
- (2) The anteroposterior roentgenogram (25)
- (3) The lateral pelvic roentgenogram (26, 27)

(1) *The observations made with obstetric inclinometer*—The obstetric inclinometer consists of a vaginal measuring rod, a calculator, and a caliper, modified to record angles as well as distances.

When the caliper is applied to the upper and lower borders of the symphysis, the height and inclination of the symphysis are noted (Fig 7). With the instrument assembled, and the end of the rod carried to the sacral promontory by the examining fingers, while the rod is in contact with the lower border of the symphysis, the length of the diagonal conjugate and its inclination are noted (Fig 7).

The angle of inclination of the symphysis, plus that of the diagonal conjugate, equals the angle between the symphysis and the diagonal conjugate (Fig 7). Thus knowing the two sides and included angle of a triangle, the third side, or true conjugate diameter, is readily computed with the calculator, which enables reconstruc-

tion of the triangle designated by the author as the *obstetric triangle* (15) (Fig 8)

To proceed with the next operation, namely, the anteroposterior roentgenogram,

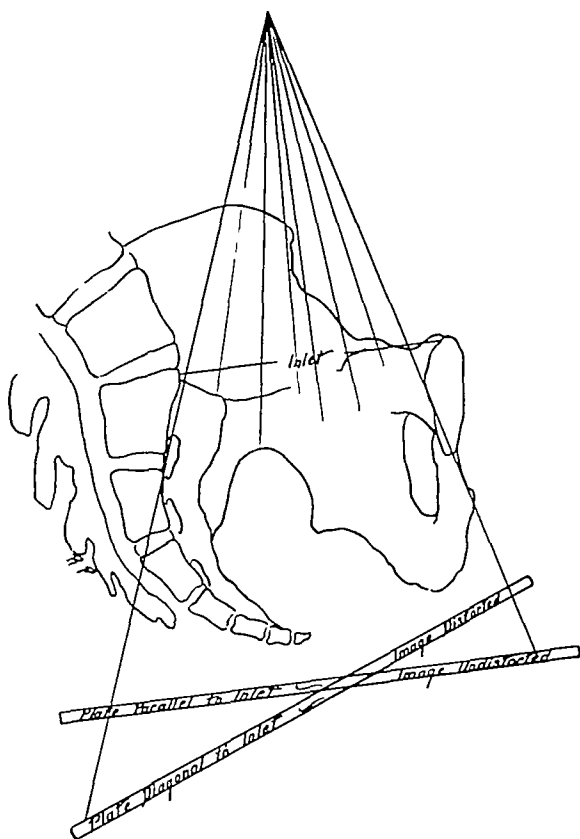


Fig 9-A

Fig 9-A When the inlet and film are not parallel measurements are inaccurate. Thus in A the image of the posterior portion of the inlet is enlarged as compared to the anterior portion when plate is diagonal to inlet, posterior portion is enlarged anterior portion is somewhat foreshortened. Where the plate is parallel, all distortion is uniform and measurable.

Fig 9-B Shows disturbance and asymmetry in image of contour of inlet due to unparallelism (lower film). The upper film is parallel and image is symmetrical and uniformly enlarged. Symmetrical enlargement is measurable.

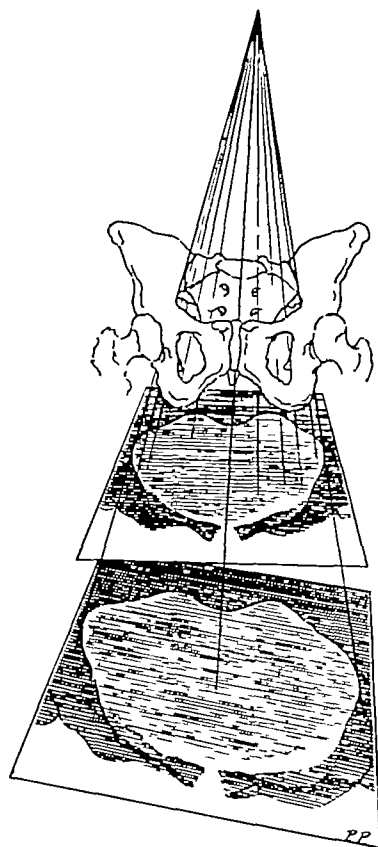


Fig 9-B

I consider this triangle as being unusually important because it is concerned with the most important pelvic dimension (true conjugate), and the inclinations of the pelvic inlet and symphysis, factors which have a direct bearing upon the facility of engagement of the presenting part of the fetus. The dimensions of the sides, as well as the size of the angles of this triangle, vary in all women. Notation is made of the length of the true conjugate diameter, for this is used as a check upon the results obtained in anteroposterior (25) and lateral pelvic roentgenography (26)

the inclination of the inlet must be determined. At present I am using the principle of the "position method," making certain that the inlet and film are parallel, in order to avoid unequal distortion (Figs 9-A and 9-B)

The inclination of the inlet is obtained in one of the two following ways

(a) With the aid of a protractor, from any point on a horizontal line, lay off the height and angulation of the symphysis, the same is done for the diagonal conjugate. The top of the line representing the symphysis is joined by a straight line with the

end of the diagonal conjugate, at the point where this line (true conjugate) crosses instead of positioning the patient, the film is positioned, for the cassette is placed under

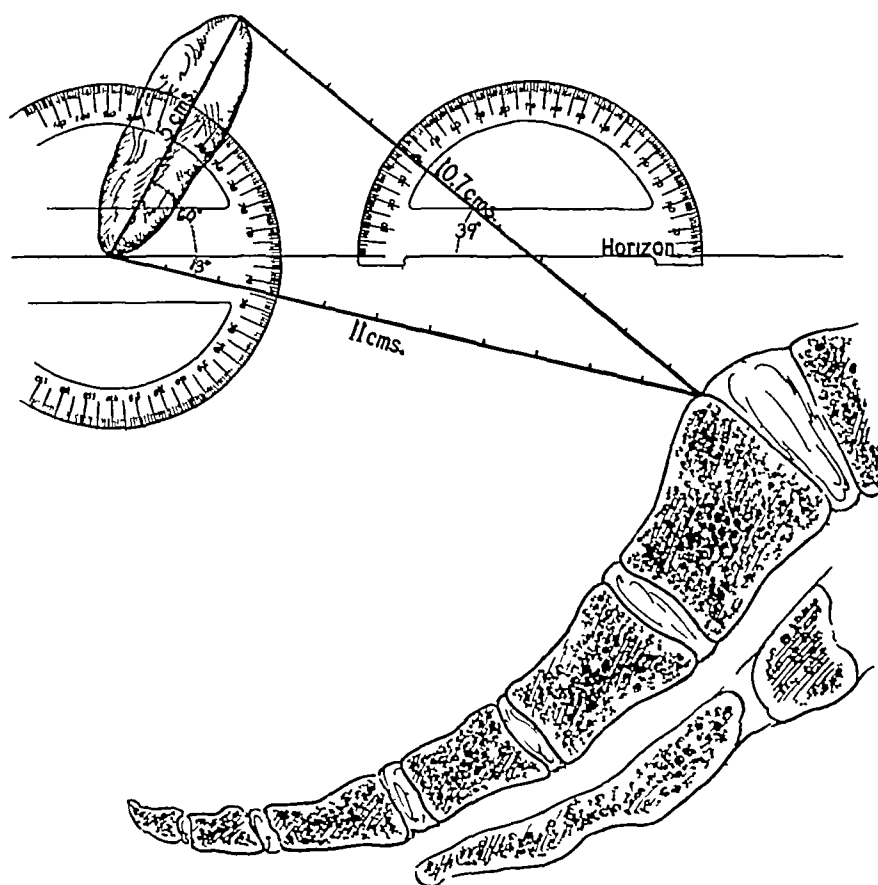


Fig 10-A Simple pelvigram Inclination of inlet is 39 degrees True conjugate measures 10.7 cm The calculator yields the same measurement

the horizon, the protractor may determine the angle of inclination of the inlet (15) (Fig 10-A)

(b) Reconstruct the interior of the pelvis with the calculator (the obstetric triangle) With an ordinary protractor measure the angle between the scales that designate the diagonal conjugate and true conjugate diameters Adding this angle to the inclination of the diagonal conjugate, gives the inclination of the pelvis or inlet (25) (Fig 8)

(2) The Anteroposterior Roentgenogram — The patient is placed upon a wooden table in supine position, the buttocks at the end of the table, with legs extended and separated widely, being supported by special leg rests or narrow tables (27) Now in-

and close to the buttocks at the same angle as the inlet Fastened to the cassette with adhesive strips, is the Lysholm grid The tube is positioned over the approximate center of the inlet and perpendicular to it and the film (Fig 11) Any inaccuracy in this set-up produces unequal distortion, resulting in error (Figs 9-A and 9-B) Exposure is made, and before removing patient from table, the target-to-inlet and inlet-to-film distances are measured

A perforated lead grid, similar to the one devised by Thoms, except that the grid rides straight up and down on two calibrated rods, is interposed between the exposed film and target at a point corresponding to the station of the inlet (Fig 12) Flash exposure is made

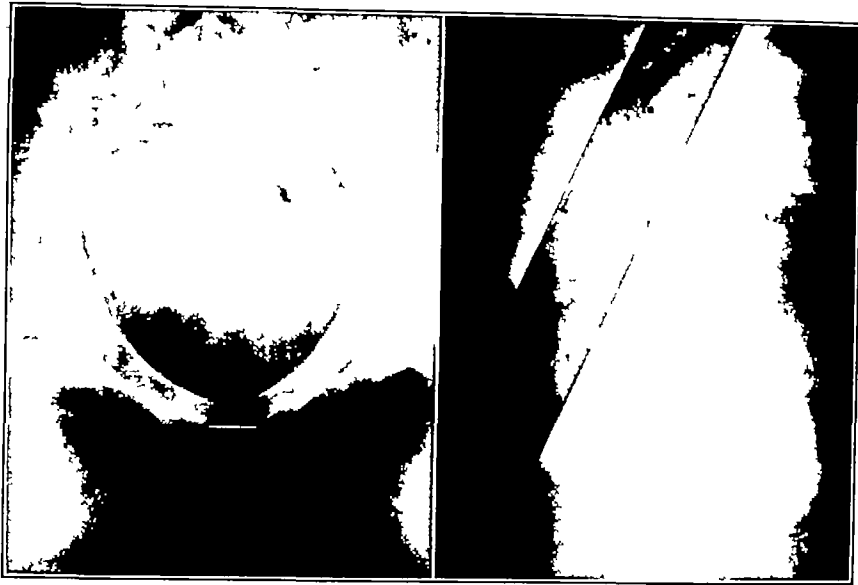


Fig 10-B Anteroposterior roentgenogram of same patient True conjugate measures 10.7 cm
 Fig 10-C Lateral pelvic roentgenogram of same patient True conjugate measures 10.7 cm (Jacobs in Amer Jour Obst and Gyn C V Mosby Co Publishers)

The resulting film is accurate and clear for several reasons. The advantage of the Lysholm grid is evident from Figures 13-A and 13-B, showing a film taken with and one without, its use.

Also, with the patient in the recumbent posture, she is more comfortable and the

rays do not have to pierce almost the entire length of the uterus and fetus, as occurs when she is positioned and the film is fixed. The contour of the inlet as well as the sacral promontory shows up well in these films, this landmark is not visible in films taken by some of the other techniques.

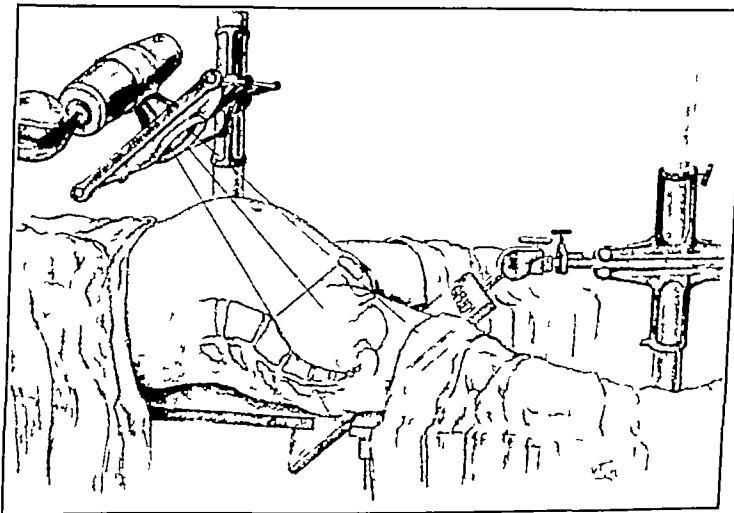


Fig 11 Position for anteroposterior roentgenogram. Buttocks at end of table and legs supported as shown. Inclination of inlet determined as described in Figure 8 or Figure 10-4 is known. Lysholm grid is fastened to cassette which is made parallel to inlet. Tube is positioned so center ray will be perpendicular to middle of inlet. Exposure made. (Jacobs in Amer Jour Obst and Gyn C V Mosby Co Publishers.)

Should the fetal head be with its longitudinal suture in the transverse of the inlet, as it

(3) *The Lateral Pelvic Roentgenogram* — The lateral pelvic roentgenogram is prob-

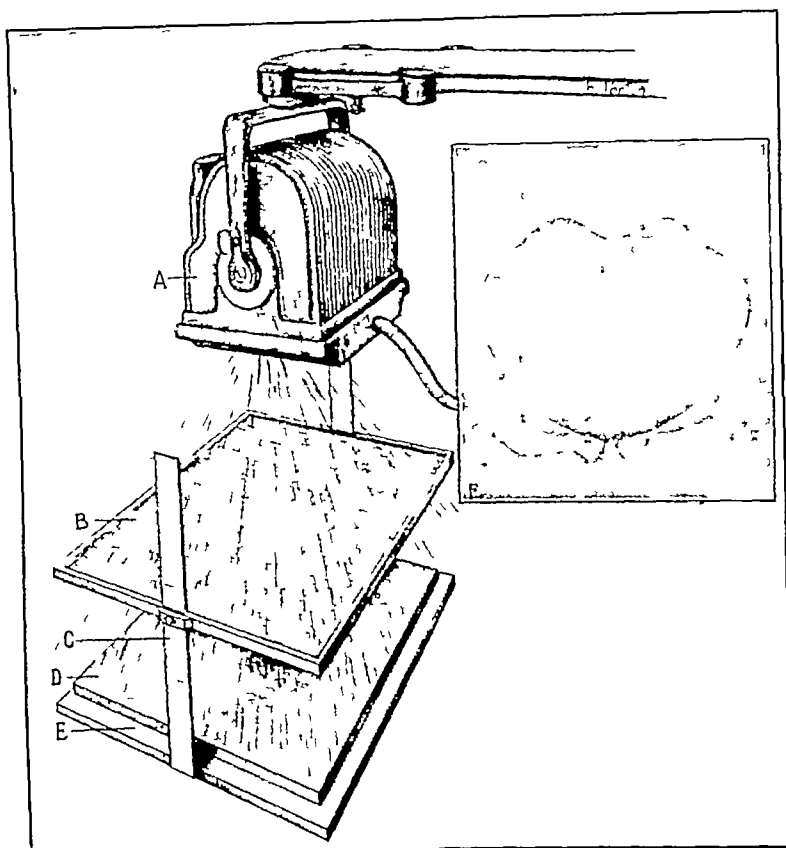


Fig 12 A points to target B is lead plate with perforations 1 cm apart throughout its surface as first used by Thoms C is calibrated rod D is cassette containing exposed film E is base of apparatus A to B is target to inlet distance B to D is inlet-to-film distance Insert F, shows the doubly exposed film after it is developed (Jacobs in Amer Jour Obst and Gyn C V Mosby Co Publishers)

often does, one may determine the occipito-frontal diameter. By counting the dots on the film, the true conjugate and transverse diameters of the inlet are measured. Should one desire to measure the oblique diameters of the inlet, he may do so with a ruler or straight edge, and then place the ruler along a line of dots and count the centimeters in that distance, in a previous paper, I have explained why this is necessary (26). The encroachment of the ischial spines upon the true pelvis may also be observed. Permit me to emphasize, as I have repeatedly done, that the middle of the upper border of the symphysis on such a film is situated as shown in Figure 10-B or 13-1.

ably the simplest, most accurate, least uncomfortable, and most inexpensive procedure. After attempting many positions, I have finally decided upon the following technic.

The patient stands with her side securely fastened to a vertical Bucky diaphragm, so that corresponding landmarks of both sides of the pelvis coincide (Fig 14). The center ray is directed perpendicular to the middle of the true conjugate diameter, which externally corresponds to a point about one inch posterior to the anterior inferior iliac spine (this point is best located in recumbent posture). Exposure is made, and then the target-to-inlet (genital crease), and



Fig 13-A Anteroposterior view taken with Lysholm grid



Fig 13-B Anteroposterior view taken without Lysholm grid

inlet-to-film distances are measured before the patient is removed. The perforated lead grid is then interposed between target and film, in the relationship formerly held by the inlet. Flash exposure (second exposure) is made, transferring dots to film (Fig 10-C).

I have previously explained (26) why two films must be used if one desires to have a line of dots extended from upper border of symphysis to promontory of sacrum (Fig 10-C, Fig 15). In cases in which one film is used, note the distance with a straight edge or a pair of dividers, between these two points, and then place on a line of dots and count the centimeters in the length of the true conjugate. Similarly, the size of the sacro-sciatic notch and the thickness of the sacrum may be measured.

Since many advantages of the lateral roentgenogram were elaborated upon in a former publication (26), I shall merely make brief reference to them at this time. By this procedure

The bulk of fetus, uterus, and amniotic fluid are avoided.

The landmarks of the true conjugate are evident.

Pelvic inclination is noted as well as ability to engage.

I have shown by x-ray that changes in posture cause alteration of pelvic inclination, also variation in size of the sacro-sciatic notch, with corresponding effect upon posterior pelvic capacity.

Rachitic changes in sacrum and existence of false promontory may be noted.

Engagement and progress of descent during labor can be visualized.

Should the long axis of the head lie in the transverse diameter of the inlet, the biparietal diameter can be rather carefully measured, for its mid-plane is practically in the line of the genital crease.

Disproportion may be noted (Fig 16).

CONCLUSIONS

- 1 The amount of roentgenographic exposure to which the mother and fetus are subjected for diagnostic procedures has been found to be free from danger. Excessive doses, such as used for treatment, may in early pregnancy cause death of the

fetus and abortion, in late pregnancy they hold a foremost place in the management of all borderline cases may interfere with the growth of the fetus

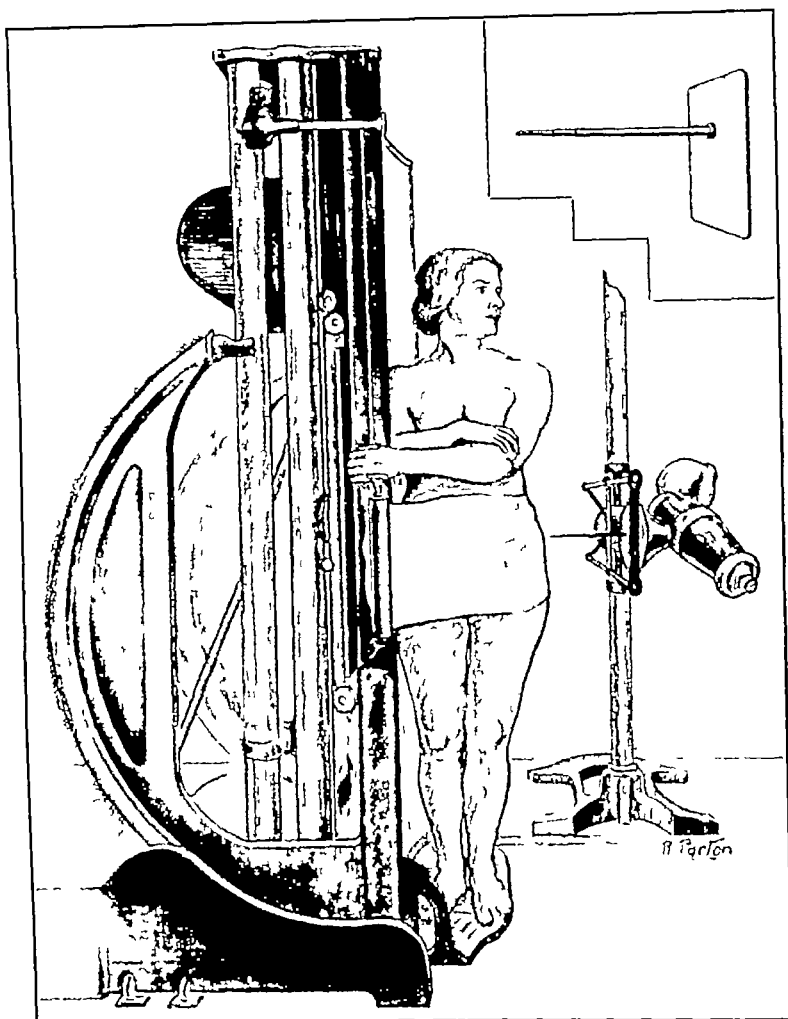


Fig 14 Set up for taking lateral roentgenogram In this position the fetal head is not apt to move The apparatus shown in insert is a telescopic indicator which I had devised for noting direction of center ray, after tube is positioned, this apparatus is removed (Jacobs in Amer Jour Obst and Gyn C V Mosby Co, Publishers)

after birth, in the mother the ovarian follicles may be seriously affected

2 The numerous applications of roentgenology to obstetrics should necessitate roentgenographic facilities in all hospitals where obstetrics is done, many unfortunate results may be avoided

3 I am not advocating my technic to the exclusion of all others I do, however, feel that such a simple and valuable procedure as lateral roentgenography should

4 Though I may have appeared too critical in commenting upon other technics, I wish to stress the fact that the authors referred to are masters, and I am among the first to respectfully value the highly scientific quality of their work

5 Regardless of the technic used or advocated, we are educating the obstetrician to its indispensibility

6 For simplicity, an ordinary flat plate will yield an image from which one can de-



Fig 13-A Anteroposterior view taken with Lysholm grid



Fig 13-B Anteroposterior view taken without Lysholm grid

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Since many advantages of the lateral roentgenogram were elaborated upon in a former publication (26), I shall merely make brief reference to them at this time. By this procedure

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CONCLUSIONS

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10 In stating opinion regarding any x-ray procedure, I have tried to express the practical views of an obstetrician

11 The relationship between obstetrics and roentgenology seems to be one-sided, the obstetrician is dependent upon the roentgenologist

12 It should be definitely understood, however, that in spite of many valuable interpretations made available through roentgenography, its application should not supersede clinical judgment, as derived from the use of the mind, the eye, the ear, and the hand of the obstetrician

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DISCUSSION

DR JOSEPH F ELWARD (Washington, D C) Dr Jacobs' paper is a masterly, comprehensive presentation and I wish to sincerely congratulate him on his effort

Radiography of the pelvis is as old as the discovery of roentgen rays and while interest has seemed to wane at times, there is a definite, unbroken thread of investigation from 1896 to the present time The Golden Age of research in this field commenced with the work of Thoms, in 1922, and is steadily progressing to a culmination which appears to be not too far in the distant future and will be reached when absolute measurements of the maternal pelvis and fetal head can be accurately determined

While it is important that both of these structures be carefully studied, the more important is the maternal pelvis The birth canal is a tortuous fixed passage, the fetus is an adaptable passenger It would seem, therefore, that the fixed passageway, rather than the adaptable passenger, should be given the first consideration



Fig 15-A

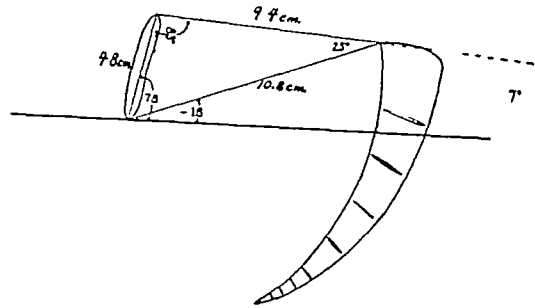


Fig 15-B

Fig 15-A Lateral roentgenogram of same patient depicted in Figure 4. Note that the length of the true conjugate checks within 2 mm with the T C as in Figure 4. Note also that inclination of inlet is very faulty. The head has to make a right angle turn to enter this pelvis. Note the extreme forward rotation of the femur and the distorted pelvic architecture. In this technic a separate film was used for the dots and then this was properly superimposed on the first film.

Fig 15-B Length of true conjugate as calculated with author's obstetric inclinometer and by a pelvigram was 9.4 cm. Short labor, normal delivery weight of infant 6 lbs 7 oz (Thighs flexed on abdomen during labor to permit engagement of head).

termine the transverse of the inlet, by using either the grid, or Roberts' simple formula. An ordinary flat plate, however, has very little other value and frequently is re-

sponsible for the mismanagement of an obstetrical case. The other important diameter of the inlet, namely, the true conjugate, is readily measured on an ordinary lateral view using either the perforated lead grid or Roberts' equation. Thus no reasonable excuse may be offered for avoiding the advantages of x-ray pelvimetry, at least in indicated cases.

7 At times the roentgenogram yields information which is unexpected and surprising.

8 In my own procedure, the measurement of the true conjugate diameter must check three ways (two cases depicted), namely, (1) Its length as calculated with my obstetric inclinometer or a pelvigram. Case 1 (Fig 10-A), Case 2 (Fig 15-B). (2) Its length as measured on an antero-posterior roentgenogram. Case 1 (Fig 10-B), Case 2 (Fig 4). (3) Its length as determined on a lateral pelvic roentgenogram. Case 1 (Fig 10-C), Case 2 (Fig 15-A).

9 I feel that too much attention is being centered upon the determination of fetal maturity, although I do not overlook the importance of such knowledge in a small margin of cases. Unfortunately, reference must be made to a highly potential factor, such as the law of averages.



Fig 16 Lateral view showing disproportion. True conjugate measures 11.4 cm. Biparietal diameter measures 12.8 cm. After delivery biparietal measured 13 cm.

THE VALUE OF HYSTEOSALPINGOGRAPHY IN GYNECOLOGIC DIAGNOSIS¹

By ALBERT MATHIEU, M D , *Portland, Oregon*

THE modern urologist or gastro-enterologist would have great difficulty in practising with any degree of success without the use of opaque materials and the roentgen ray. The same difficulty confronts the gynecologist in making a finished diagnosis, in predicting prognosis, and in accomplishing proper treatment if he deprives himself of the use of hysterosalpingography. Many of the pathologic conditions with which the gynecologist must contend involve the cavities and linings of the uterus and tubes, and hysterosalpingography offers the best and simplest means of locating and estimating extent and severity of these conditions. The day has passed when one needs guess as to the condition of the internal os, the condition of the endometrium, the size and contents of the uterine cavity, and the patency of the tubes.

My first impression of the method was that it had limitless possibilities for the elucidation of gynecologic diagnosis, but that it might present serious dangers. Increased experience, however, has allayed my fears and convinced me that hysterosalpingography, when properly executed, is safe, easily performed, a minor procedure from the patient's standpoint, and of the utmost value in a certain number of difficult gynecologic studies.

The contra-indications are active, serious infection of the genital tract and normal pregnancy. It is obvious that strict aseptic and antiseptic precautions should attend the injection, and that the greatest care should be exercised in carrying out the various steps of the procedure. The maneuver is harmful when it is improperly or carelessly done, and dangerous if certain contra-indications are not ob-

served, it is unsuccessful if improper instruments or poor oil are used, and useless if one cannot read the films correctly. In over 1,200 injections of iodized oil into the uterus and tubes, I have had no catastrophes and no untoward results to be regretted.

The technic may be made very simple or very involved. There is no need for a manometer, with its long tubing, or other complicated instruments which are difficult to manipulate, and there is no need for hospitalization of the patient. By using the technic herein described, one can complete the maneuver in approximately two minutes, with a maximum of results and a minimum of discomfort to the patient.

The patient is placed in lithotomy position over a Bucky diaphragm at the end of a table which has stirrups. A good light reflected into the vagina is necessary. A vaginal speculum is inserted, and the vagina and cervix are cleaned of discharge. Tincture of iodine is applied to the cervix and to the external os. The anterior lip of the cervix is then grasped with a single tooth volsellum to hold it in a fixed position. The oil-filled, short-tipped cannula, attached to the syringe, is inserted into the external os, pressing the acorn of the cannula gently against its opening, and the oil is injected slowly into the uterine cavity. When the cavity is filled, the oil will proceed into the tubes if they are patent. At this time the patient will experience painful uterine contractions, and the oil will leak backward between the acorn of the cannula and the cervical opening. The amount of oil required for the injection is usually from five to eight cc (more, however, if the uterine cavity is large, and less if it is small). The amount of pressure used in the injection should be scarcely more than that used

¹ Presented before the Radiological Society of North America at the Twenty second Annual Meeting, at Cincinnati, Ohio Nov 30-Dec 4 1936

Dr Jacobs quotes Bartholomew as stating that he (Bartholomew) obtained positive roentgen evidence of a fetal skeleton in one-third of his cases at five months, one-half at six months, and almost constantly thereafter. I cannot agree with this statement. To be unable to demonstrate 100 per cent of fetal skeletons at six months is little short of a diagnostic crime, and it is no more than an even wager to say that 100 per cent may be demonstrated at the completion of the fourth month and many considerably earlier.

I now present slide No 1 (see Fig 1, Dr Jacobs' paper). The last menstrual period was May 16. First contact was May 31. Film made September 1. Duration of pregnancy cannot exceed 93 days, or three lunar months plus nine days.

Slide No 2 (see Fig 2, Dr Jacobs' paper). The last menstrual period was January 3. The first contact was January 18. The film was made May 9. The pregnancy, therefore, cannot exceed 112 days, exactly four lunar months.

The original films of these and several other cases are available for study by anyone interested.

The essayist mentions the intra-uterine use of opaque media as a diagnostic procedure and advises caution. I wish to emphasize the admonition, as I am unalterably opposed to the invasion of any pregnant uterus for any purpose except as a life-saving measure. A life-saving measure situation is rare indeed. A routine diagnostic procedure is never justified.

The author has pointed out the fallacy in the roentgen signs of fetal death and mentions fetal age determination by the stage of development of ossification centers. These show considerable variation, and approximate age determinations only are the rule. The experienced obstetrician

should be able to do quite as well by simple palpation.

The various methods of roentgen pelvimetry (and Dr Jacobs has briefly discussed nine such) may be compared in a general way to the old "saw" that when there are many different remedies for a disease, none of them is of great value. I do not mean that the work done should be discarded or ignored, as anything added to the sum total of human knowledge is not lost, but I wish to emphasize that we must recognize the limitations of roentgen pelvimetric methods and be aware of any simpler obstetric procedure that will give us favorably comparable results.

Nor should we forget that all physicians who refer obstetric patients to us for roentgen consultation are not skillful, highly trained obstetricians. Time will not permit any discussion of the nine methods considered by Dr Jacobs. All have some advantages. None is ideal.

The author's method of determining pelvic measurements in which he takes into consideration the inclination of the plane of the superior strait seems to be the most nearly accurate of the methods for this particular phase. All the methods for determining the size of the fetal head have practically the same fault, that is, inaccuracy because of distortion and inability to precisely determine the exact plane in which the head lies and to adequately compensate for the distortion. The methods using volumetric content as a basis are or may be fallacious in certain particulars, as Dr Jacobs has told us.

We, as roentgenologists, can give valuable information to the obstetrician and the value to him will be in direct proportion to his knowledge and skill in his chosen field.

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The technic may be made very simple or very involved. There is no need for a manometer, with its long tubing, or other complicated instruments which are difficult to manipulate, and there is no need for hospitalization of the patient. By using the technic herein described, one can complete the maneuver in approximately two minutes, with a maximum of results and a minimum of discomfort to the patient.

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in giving any injection through a syringe. By observing this precaution there can be no danger of excessive pressure. Once



Fig 1-A Short-tipped cannula



Fig 1 Hysterosalpingogram of normal uterus and tube. Note triangular shape of uterine cavity without filling defects, normal proximal two-thirds of tubes and dilated distal ends with partial spill of oil.

the cavity is filled, the roentgenogram is made with the cannula still in position, then the cannula is removed and the oil is allowed to run from the cervix. This completes the injection which, with exposure of the film, usually takes two minutes after the vaginal speculum has been inserted. By using the short-tipped cannula (Fig 1-A) the position of the ute-

rus or the direction of the canal need not be known, and sounding of the uterus is unnecessary, since the short-tipped cannula does not extend to the internal os.

It is always well to describe the technique to the patient, and to advise her that she will be told in advance of each pain—that associated with the grasping of the anterior lip with the volsellum, that associated with the insertion of the cannula, and that associated with the filling of the uterine cavity. When she is so advised, and is told further that the entire procedure will be over in two minutes, her discomfort is lessened, anticipation of severe pain is prevented, and co-operation is assured.



Fig 2

Fig 2 Stricture of the internal os



Fig 3

Fig 3 Localized hyperplasia in the region of the internal os

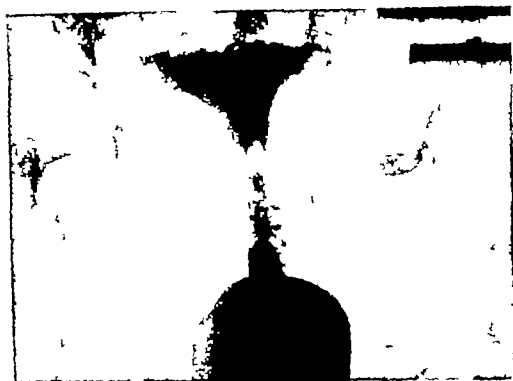


Fig 4 Generalized hyperplasia of the endometrium



Fig 5 Filling defect caused by polyp of the uterine cavity

Another roentgenogram should be taken from eight to 24 hours later if one wants to know about the patency of the tubes. By this time the tubes and uterus will be empty of the oil, and if the tubes are patent there will be some filmy traces of oil in the pelvic cavity. In the cases in which the tubes are closed, the actual site of the closure will be seen—in the cornu, in the tube proper, or at the distal extremity. All the cavities of the uterus and tubes reached by the oil will be visualized with the roentgen ray.

NORMAL CERVICAL, UTERINE, AND TUBAL CANALS

While all uterine and tubal canals are different, there can be established, more or less, a normal standard (Fig 1). The

uterine canal is usually distinct in outline and triangular in shape. It has a definitely opened cervical canal and no filling defects. A tube—rather tiny and tortuous, but distinctly outlined and dilated at its distal third—extends from each upper horn of the uterine cavity. When sufficient oil is injected, one can see some slight spilling of the oil from the dilated distal ends. However, the diagnosis of patency of the tubes must rest on a second plate, taken from eight to 24 hours after the injection. The presence of a filmy deposit of oil scattered in the pelvis is necessary in making a diagnosis of patency of the tubes.

CERVICAL CANAL

Kinks, obstructions, growths, dilatations,



Fig 6



Fig 7

Fig 6 Polyp of the uterine cavity projecting down from the fundus.
Fig 7 Several small fibroids on the posterior surface of the lower segment of the uterus, causing bulging and dilatation of the lower segment of the cavity.

in giving any injection through a syringe. By observing this precaution there can be no danger of excessive pressure. Once



Fig 1 A Short-tipped cannula

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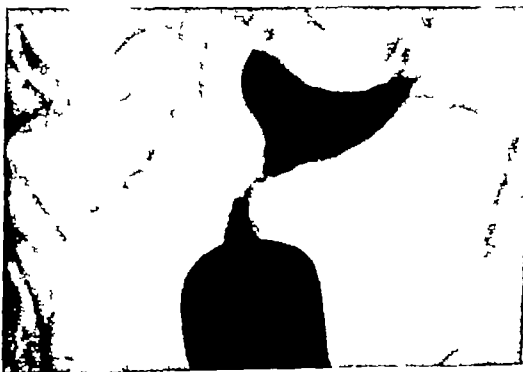


Fig 2

Fig 2 Structure of the internal os



Fig 3

Fig 3 Localized hyperplasia in the region of the internal os



Fig 11 Sagittal section through bicornuate uterus containing missed abortion in horn of Figure 10

congenital anomalies, can also be clearly outlined (Figs 8, 9, 10, 11, and 12)

Iodized oil and roentgen ray have been used in the diagnosis of abdominal pregnancy. Oil visible in the small uterine cavity proved definitely that the pregnancy was not in the uterus.

I have been able to establish what appears to be a pathognomonic sign for certain cases of adenomyoma of the uterus. In those cases in which there is an infolding of the endometrium in such a manner as to make long, cryptic tubes, dipping deeply into the myometrium, the iodized oil will penetrate these cryptic tubes which will then be beautifully visualized. This is the only situation wherein oil can be seen penetrating a myometrium in this characteristic manner (Fig 13)

TUBES

Patency or non-patency of the tubes can be established, and in case of closure, the site of the obstruction can be localized. The position of the tubes can easily be seen—one can see whether they are hanging low in the pelvis or attached at some high point, whether they are exceptionally tortuous or kinked, and whether they are normal in size and contour.



Fig 12 Double uterus. Patient had two vaginæ and two cervices. Note evidence of bilateral hydrosalpinges.

The normal tubal cavity will have a characteristically fuzzy appearance, while the cavity of the tube that is chronically diseased will have a sharply outlined, wiry appearance (Fig 14). The condition of the tubal cavity, or its position, is frequently of clinical significance. In differentiating between a tubal mass and an ovarian mass, one can readily see that if the tube fills normally to its distal end it can be excluded as a source of the mass.

Small hydrosalpinges which cannot be detected with bimanual examination are often revealed by hysterosalpingography. In about 50 per cent of these small hydrosalpinges the cornual ends of the tubes are open and allow oil to enter, and the configuration of the tubes shows in a characteristic manner. In the film taken at the time of the injection, the tubes show a dilatation of their distal third from three to four times the normal, there is no evidence of spilling, the oil seems to be contained in well-outlined sacs in the ends of the tubes, and the proximal two-thirds of the tubes appear to be normal (Figs 15 and 17). The 24-hour film shows the uterus and the proximal two-thirds of the tubes empty and clear of iodized oil, and the shadows of the distal ends of the tubes the same as they were the day before (Figs 16 and 18). If another film is taken a week or two later, the same bags, or shadows, unchanged, will be seen. These shadows of the iodized oil

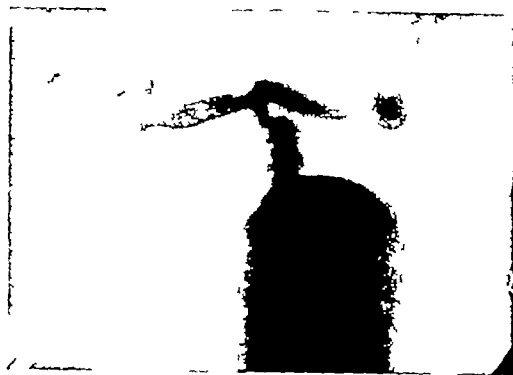


Fig 8 Bicornuate uterus Roentgenogram made vertically through the fundus



Fig 10 Missed abortion in horn of bicornuate uterus Aschheim-Zondek test negative

and stenoses of the cervical canal and internal os are visualized (Fig 2) The visualization of the actual size, shape, and form of the cervical canal is of great importance in the diagnosis of dysmenorrhea, sterility, and bleeding Frequently a severe obstruction is found when it is not suspected clinically, and it is not uncommon to have demonstrated a localized hyperplasia of the endometrium just above a stricture or stenosis of the cervical canal This localized hyperplasia, whether due to improper drainage or to infection, might frequently be the cause of menorrhagia or metrorrhagia (Fig 3)

UTERINE CAVITY

The size, shape, and position of the cavity of the uterus are shown Growths

in the cavity, or those bulging or pressing into the cavity, can be observed The condition of the endometrium is usually made plain, so that hyperplasia, either generalized or local, can be seen (Fig 4) Polyps, carcinomatous growths, or placental debris are demonstrated by more or less characteristic filling defects (Figs 5, 6, and 7) In visualizing the uterine cavity in the presence of a large myoma, the use of a small lead wire (fitted on the abdominal wall around the contour of the tumor, so that when the roentgenogram is made the lead wire will outline a considerable part of the tumor and the shadow of the iodized oil in the uterine cavity) will show the relationship between the tumor mass and the cavity of the uterus Double uterus, in all its various forms, and other

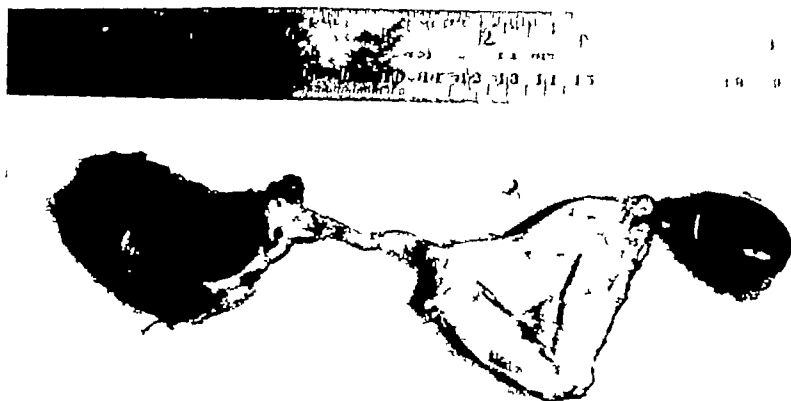


Fig 9 Sagittal section through uterus and tubes of Figure 8



Fig 19

Fig 20

Fig 19 Ectopic pregnancy aborting from the distal end of right tube Note how oil drapes itself about the aborting mass

Fig 20 Ectopic pregnancy aborted from distal end of left tube Note how oil drapes itself about the aborted mass

in definite, unchanging form are a pathognomonic sign of hydrosalpinges. Since the condition is usually bilateral, one sees in the 24-hour film the shadows of two bags of iodized oil hanging down, one in each side of the pelvis. The emptying of the tube in a case of hydrosalpinx is different from the emptying of a normal tube. The iodized oil in that portion of the tube which still possesses a good muscular layer is evacuated into the uterus by peristaltic waves, while the iodized oil contained in the sac remains there, because the musculature in this portion of the tube is so thinned out that it cannot function.

There is still another sign which is characteristic of hydrosalpinx as visualized with iodized oil and the roentgen ray. Often when the oil enters the tube, it drops into the sacculated portion containing the serous fluid, mixing with this fluid and forming a rather coarse emulsion, and the shadow on the film shows many droplets of iodized oil in the fluid in the sac. There is one possible source of error in reading this sign. The droplets may also be seen when oil spills through the distal end of the tube and falls into free fluid which may be present in the pelvis or in the cul de sac. This happens rarely, but when it does, the droplets are seen low down in the pelvis, near the midline, and do not appear contained in a sac, and

the 24-hour film will show this oil disseminated throughout the pelvis. If this emulsion is contained in the tubal end, it will still be there on the 24-hour plate as a bag of oil, not as an emulsion, and will not show the droplet sign.

In all cases where plastic operations have been done on the tubes for the purpose of correcting sterility, the results of the operation can eventually be checked by the use of hysterosalpingography, so that one can determine whether or not the operation was a success.

ECTOPIC PREGNANCY

I have used hysterosalpingography in several cases of tubal pregnancy as an aid in diagnosis and have obtained practically 100 per cent correct diagnoses. In tubal pregnancy, aborting from the distal end of the tube, the injected oil enters all the crevices between the aborting pregnancy and the walls of the distal end of the tube in such a way that it literally drapes itself about the mass which can then be visualized by the x-ray (Figs 19 and 20). In my cases of tubal pregnancy in the midportion of the tube, the injected oil went down to the site of the pregnancy, and, because this site was apparently well sealed off, ended abruptly and showed in a characteristic shadow (Figs 21 and 22). This also proved quite



Fig 13

Fig 13 Adenomyoma of the uterus

Note iodized oil in crypts formed by infolding of endometrium into the myometrium



Fig 14

Note the wiry appearance of chronically diseased tubes with the absence of normal distal dilatation



Fig 15

Fig 15 Bilateral hydrosalpinges Note sacculated dilatation at extreme end of each tube



Fig 16

Fig 16 Film taken 24 hours after Figure 15 Note bags of oil



Fig 17

Fig 17 Bilateral hydrosalpinges Note sacculated dilatation at end of each tube

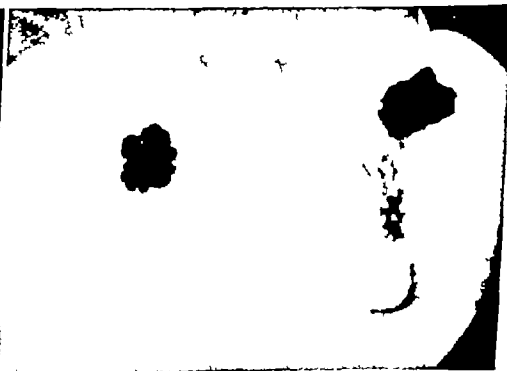


Fig 18

Fig 18 Film taken 24 hours after Figure 17 Note iodized oil retained in sacculated ends of tubes

- 1 In detecting patency or non-patency of the tubes,
- 2 In the determination and localization of occlusion of the tubes,
- 3 In the visualization and orientation of the uterine cavity, including the internal os,
- 4 In the diagnosis of intra-uterine tumors,
- 5 In demonstrating other abnormalities of the uterine and tubal cavities (uterine subinvolution, infantile uterus, tubal kinks),
- 6 In the diagnosis and localization of ectopic pregnancy,
- 7 As an aid in the diagnosis of abdominal pregnancy,
- 8 In checking the results of plastic operations on the tubes,
- 9 In determining whether a tube or the uterus in the region of the pelvic mass is or is not an integral part of the mass,
- 10 As an indication for hysterectomy for fibroids in preference to myomectomy in cases in which the tubes can be shown to be occluded,
- 11 In the study of dysmenorrhea,
- 12 In the visualization of hyperplasia of the endometrium,
- 13 As an aid in the diagnosis of adenomyoma,
- 14 Finally, and by no means a minor consideration, for didactic and academic purposes

DISCUSSION

DR A. DAVID WILLMOTH (Louisville, Ky) I have listened with great interest to the three papers presented here on a method of diagnosis in gynecologic work. Having been a gynecologist and an abdominal surgeon myself for a number of years, it naturally appeals to me in more ways than one.

And yet I can see there are many disadvantages, perhaps, that the surgeon has to take into consideration in private work over that of a municipal hospital, perhaps, where final reports and where considera-

tions for mortality do not enter into the question.

There were some slides shown here of pregnancies, diagnosed by the intra-uterine method of injecting oil. I would want to be doubly sure, in my State of Kentucky, under our present laws, that I had legal permission to inject this oil before I would attempt it on a case of suspected pregnancy, and even then I think we perhaps would be subject to the woman and her husband coming into court later and saying they did not fully understand the paper they signed.

We would again have to face a court in a case of that kind. That was one of the questions that came to me during the delivery of the Symposium.

Another Speaker, in stating his subject (I think it was Dr. Randall, from the Mayo Clinic), said that you must be doubly sure the tube was closed, if not, they'd name the baby for you. I do not know of any method we have of knowing how long those tubes would remain closed, even though we did determine definitely that they were closed at that time, and to tell the woman that she would be forever sterile would be taking in a great deal of territory.

I could cite you a case in my town of a legal contest in which the court was told the woman was sterile. The case went to the Court of Appeals on a large judgment and before the verdict was handed back down she presented the husband and the court with a nice girl baby.

So I do not know just how long tubes remain closed because Nature will open any tubal canal that is humanly possible to be opened. We know that. You can't close the pylorus of the stomach, for instance, and keep it closed even though you put a silver clamp on it. Nature will open it in such a manner that it will permit food to pass through—she is determined to do all she can for the patient. In that way a tube that is closed to-day may not be closed in two or three months from now.

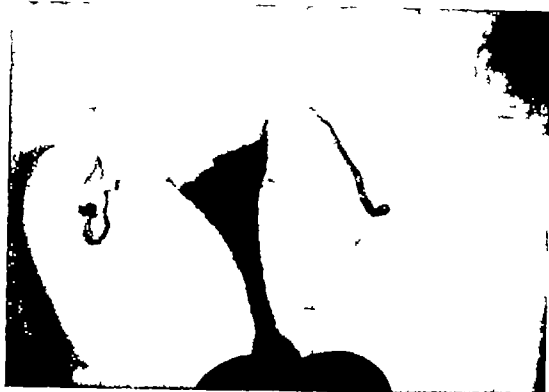


Fig 21

Fig 21 Ectopic pregnancy in the midportion of left tube. Note how tube ends abruptly in a rounded manner just proximal to the tubal pregnancy. Note filling defects at each end of uterine cavity. These are due to filling defects caused by decidua. This roentgenogram does not visualize the ectopic pregnancy. It merely visualizes the characteristic finding in that portion of the tube proximal to an ectopic pregnancy in the midportion of the tube.



Fig 22

Fig 22 Ectopic pregnancy in the right tube. Note how tube ends abruptly in a rounded manner just proximal to the tubal pregnancy. This roentgenogram does not visualize the ectopic pregnancy. It merely visualizes the characteristic finding in that portion of the tube proximal to an ectopic pregnancy in the midportion of the tube.

conclusively what has long been suspected by many, that the bleeding from the uterus in cases of tubal pregnancy is from the uterine wall and not from the site of the tubal rupture. While I do not advise hysterosalpingography except when it appears necessary to establish the diagnosis, I do feel that the injection of iodized oil into the uterus and tube in a case of tubal pregnancy is practically harmless. When the injection is done carefully and by one experienced in its use, there is no reason to believe that it can do harm. I can present sufficient proof that its use is of the highest value. The least that one can say in behalf of hysterosalpingography is that when both tubes fill well and normally to their distal ends, one can surely rule out tubal pregnancy. I have been able to establish what seems to be a pathognomonic x-ray sign of tubal pregnancies—for those ruptured or unruptured in the midportion of the tubes, and for those aborting from the distal ends of the tubes. I have located the site of tubal pregnancy in 12 patients by means of hysterosalpingography.

CONCLUSIONS

Hysterosalpingography is as valuable

and as welcome as visualization of the bronchial tree or the urinary tract. Very few untoward effects have been reported in the literature, most of those that have been reported were due to faulty technique. If one uses good technique and avoids the maneuver in the presence of active infection or normal pregnancy, it offers a maximum of results in diagnosis as pertains to the cavities of the uterus and tubes with a minimum amount of discomfort. It is such a valuable aid in diagnosis that if more hysterosalpingograms were taken, fewer hysterectomies would be performed when curettage would suffice, and fewer curettages would be done when hysterectomy is necessary. Its most valuable field is in the study of sterility, wherein it is important to decide whether or not the tubes are patent, and to determine the position and nature of obstructions. In several of my patients pregnancy followed soon after the injection of iodized oil when this was the only procedure done that might have had a corrective value. In such cases it is reasonable to assume that the tube was actually opened in some way by the process.

To recapitulate, the gynecologist will find hysterosalpingography valuable—

tion Of course, there are many factors that we do not know about when we get to talking about sterility Nevertheless,—and this has been borne out, I think, in many places—somewhere between 15 and 20 per cent of sterile women in whom one does not find any evidence of disturbance of physiology or pathologic change, will conceive in the third or fourth month succeeding the injection

I have never told any woman that she absolutely could not get pregnant If the diagnosis of tubal occlusion is made, the prognosis to the patient is definitely softened, because I quite agree with the Doctor from Louisville that one should not as a rule give a definitely unfavorable prognosis Obviously, anybody who sees sterile women does not depend upon this particular phase of the thing to give a final diagnosis as to the particular case

We all recognize that there are many other factors beside this However, if a patient comes to you complaining of sterility, you have to demonstrate that she has patent tubes or all your other therapeutic measures will have been of no avail

I would like to emphasize just one other thing and that is this question of what we have called "physiological resistance" I have so frequently seen it lead to an erroneous diagnosis that I believe it should always be kept in mind, until excluded, so that we do not make the mistake of making a diagnosis of non-patent tubes in cases in which the failure of the medium to pass is based purely on the physiologic and not the pathologic condition

DR R A ARENS (closing for Dr Stein)
Answering Dr Peirce's question as to how much gas is employed in pneumoperitoneum, it has been our custom to use 1,000 c c, either by the intra-uterine or trans-abdominal route

Why some individuals absorb gas much more readily than others is very difficult for me to say In the past I have seen air remain in the peritoneal cavity for as long as 30 days, whereas in the average normal individual at least from 90 to 95 per cent would be absorbed within from 48 to 72 hours

The gas we prefer is carbon dioxide The absorption is approximately 80 per cent in 20 minutes, so that if you fail to get the films you desire immediately after pneumoperitoneum is induced, you have no recourse but to repeat

We have found one thing of interest, that even using the same container of carbon dioxide for some period of time, the gas apparently changes somewhat, so that it fails to absorb so rapidly Whether it is because of a chemical reaction of the gas with the metallic chamber of the container, I do not know

As an indication of what might happen in the gas container, the following may be of interest the manometer that we employ, to determine the amount of gas used, is made of glass On one occasion we broke off a little arm and, naturally, this was immediately sent to the glass blower, to have a new arm put on He was quite surprised that he could not repair it because the moment he put the glass in the flame it cracked and chipped, but would not fuse or melt It chipped and kept on chipping until the arm was broken off to the main chamber and there was nothing left to do but to make a new one The character of the glass undoubtedly was changed by this contact with the gas So it may be that carbon dioxide in a metal tank may change its character somewhat so that after a period of time the absorbing qualities are altered Therefore, we have made it a policy to change our gas containers with comparative frequency

I would like to ask the Speakers, in closing, how they determine, for instance, the following You have a tube that is open, that permits gas and oil both to pass through, and then has behind it or surrounding it adhesions that are really giving the patient trouble Does roentgen examination give any particular information over that which could be obtained by a bi-manual examination, pertaining to a pregnancy that is very much desired?

I have a number of patients under observation now, concerning whom that is true There are so many other variable factors—the husband, for instance,—the various hormones, chemical conditions within the cervical and uterine canal—that all have to be taken into consideration Even if we determine the tubes are patent are we very much better off?

DR ALBERT MATHIEU (closing) One of the greatest difficulties we have when talking about things that are either new or strange is that we are so constantly misunderstood I think I very carefully said that normal pregnancy was a definite contra-indication to this method of diagnosis

The fact that I showed a pregnancy here does not mean anything to the contrary This woman was about to be aborted for some other purpose, and this film was taken purely in an academic way We still say that normal pregnancy is a contra-indication

Neither do we attempt to show that hysterosalpingography is a panacea for all diagnostic ailments in gynecology It is not It merely visualizes the cavity of the uterus and tubes to the point where the oil will go That is all it will do

We think the method is quite harmless, and in over 1,200 injections that I have done myself or supervised there has been no catastrophe and no regrettable result

It is obvious, of course, that if the contra-indications are not observed, if improper medium is used, if improper instruments are used, or careless technic is performed, the method can be harmful

and can be dangerous But there is no need for any hualabaloo about it at all because we know it is quite simple and instances of untoward results are minor and few, compared to the sum total of the benefit evolved

When I spoke at Cleveland the other night before the Clinic of Dr Crile, Jones reported 12 cases of pregnancy within three months after the injection

I do not mean to say it has any value as treatment, although I could understand how the injection of oil might unseal the distal end of the tubes to the point where penetration of the spermatozoa could obtain

DR LAWRENCE M RANDALL (closing) I have just a few things I would like to say in closing One is that out of these 600 patients I injected with iodized oil, there were three (and we followed these patients very closely) in whom there was evidence of pelvic inflammation following the injection of the oil In all of these patients the diagnosis that was made at the time of injection was chronic salpingitis with tubal occlusion, and we did not find any evidence of iodized oil in the peritoneal cavity

In other words, we simply caused an exacerbation of an old inflammatory condition

I do not propose to go into the technic or the contra-indications except to say that every care is given these patients to safeguard them from the sequelæ, and in the patients we have seen I am sure the methods, both of them, have been of definite benefit to the patient with a risk so small that you can disregard it

Dr Peurce mentioned the question of oil being left in the tubes I have a patient I have been following for two and a half years, whom I injected, who still has some opaque material in her tubes, without any symptoms The material is almost as radiopaque as it was when I put it in

I believe there is definite therapeutic benefit to be considered when you do either a tubal insufflation or an iodized oil injec-

irritation, often is persistent, frequently fails to respond to treatment, and often interferes with sleep. If associated with blood-streaked mucoid sputum, in the absence of tuberculosis, it is highly suggestive of bronchial neoplasm. Profuse purulent expectoration in cancer is indicative of extensive bronchial infection, the result of bronchial obstruction with retention of secretions. It cannot be interpreted as an early symptom. Hemoptysis may occur early or late and varies in amount from slight streaking to frank hemorrhage. A large blood loss, however, is usually a late manifestation.

It is interesting to note that wheeze as a symptom of early cancer is not often mentioned in the medical literature (2 and 3). One observes however that asthma often is considered as a diagnostic possibility (Fig 1). Wheeze is a common symptom of partial obstruction to a bronchus. It is not continuous, being influenced by cough and deep inspiration and often is not noticed by the patient. It is best heard during and at the end of expiration when the bronchus normally becomes narrowed. A wheeze, taken in conjunction with cough and occasional blood-streaked or no sputum, constitutes very strong evidence of newgrowth producing early partial obstruction to a bronchus.

Pain is not a common early manifestation of carcinoma originating in the larger bronchi. It is, however, considered as "the most common signal symptom" of peripheral carcinoma and is due to peripheral extension of the growth to the pleura and extrapleural structures (4). There may be an associated area of tenderness. Dyspnea, pleural effusion, weight loss, weakness, fever and sweats, dysphagia, hoarseness, pupillary changes, and engorgement of the veins of the neck and chest are commonly evidences of advanced disease and are principally of didactic interest.

Radiographic Features—Hruby and Sweany (5) expressed the opinion that "perhaps no other one factor has been so



Fig 1 Film made in the case of a man aged 54 years who gave a history of perennial hay fever for past five years. In 1935 the hay fever symptoms did not clear up. Cough, wheezing, and shortness of breath persisted, later, sputum became blood streaked. This case was treated as a case of bronchial asthma for eight months. The roentgenogram revealed heavy root shadows more marked on the left side. Bronchiectasis was suspected and lung mapping was recommended. At bronchoscopy there was found a neoplastic lesion in the left lower lobe bronchus. Histologic examination of tissue removed was reported by Dr B L Crawford as squamous-cell carcinoma (Film by Dr J T Farrell, Jr).

important as the roentgenogram in contributing to the changed attitude toward cancer of the lung." In 1932, Manges (6) stated that the diagnosis of cancer, as a rule, is not made until the lesion is well advanced. He found that the vast majority of the proved cases showed either a large tumor mass, atelectasis of a lobe, or a large area of exudate-filled lung distal to an obstructing growth. In a study of a group of 50 cases of bronchial carcinoma, Farrell (7) observed that atelectasis was the most common radiographic finding. These observations indicate that the roentgenologist sees patients late, when the disease is sufficiently far advanced to obstruct bronchi and interfere with drainage of secretion and when suppuration is present distal to the obstruction. This need not

CARCINOMA OF THE BRONCHUS¹

By LOUIS H. CLERF, M.D., *Philadelphia*

THE remarkable disproportion between the large number of reported cases of primary carcinoma of the bronchus and the small group that have been successfully treated suggests that an inquiry be made to ascertain its causes. It is generally recognized that roentgenology and bronchoscopy have aided immeasurably in the diagnosis of bronchial carcinoma. With recent advances in thoracic surgery, lobectomy, even pneumonectomy in selected cases, are considered as relatively safe procedures. Improvement in equipment and technique in the employment of the roentgen ray and radium in therapy gave the hope that relief would be secured by these agents. The meager reports of cases cured by any kind of radiotherapy would seem to indicate that the only satisfactory treatment at present is surgical extirpation. There are many factors that bear on the problem of surgical treatment of carcinoma of the bronchus. Many growths are so located anatomically that surgical removal is not compatible with life. Carcinoma is commonly observed after the fifth decade of life, a time when risks incident to surgery of the lung are greatly increased. There remains, however, a large group of patients who could be treated surgically were it not for the fact that the diagnosis is made late and the growth is too extensive. It would appear, therefore, that the most important reason for the disproportion between the reported and the successfully treated cases of carcinoma of the bronchus is delay in diagnosis.

If there is to be any advance in the surgical treatment of bronchial carcinoma, it will depend almost entirely upon arriving at a correct diagnosis early in the disease. This responsibility rests primarily with the

clinician who usually is the first to be consulted by the patient, however, the roentgenologist and the bronchoscopist must share a part of the burden for they too are called upon to aid in the diagnosis. The clinician should be "cancer of the bronchus-minded" as well as "roentgen-ray-minded." He should also appreciate the importance of endoscopic examination in cases of obscure chest signs and symptoms. In addition, he should realize that when cancer is a diagnostic possibility it is important to arrive promptly at a diagnosis.

Certain of the diagnostic aspects of carcinoma of the bronchus will be considered. It is not intended to present a detailed account of the symptoms and physical signs of bronchial carcinoma, however, the roentgenologist as well as the clinician should be familiar with these. Of vast importance in bronchial carcinoma as in carcinoma elsewhere is the ability to recognize its early manifestations.

Clinical Considerations—No group of symptoms or signs can be considered as diagnostic of carcinoma; they are dependent on the location of the growth and its influence upon adjacent structures. The early symptoms are important as the correct interpretation of these will lead to early diagnosis. A diagnosis made when the carcinoma is advanced is of statistical value only, from the patient's standpoint it is of little or no importance. This was well stated by Tuttle and Womack (1): "In the diagnosis of cancer any method that requires metastasis before it can be utilized may as well be discarded so far as the welfare of the patient is concerned." A statistical study of cases reported in medical literature and of records at the Bronchoscopic Clinic, Jefferson Hospital, indicated that cough with or without sputum was the most common early symptom of carcinoma involving the larger bronchi. Cough is the result of bronchial

¹ Presented before the Radiological Society of North America at the Twenty-second Annual Meeting at Cincinnati, Nov. 30-Dec. 4, 1936.

logic examination. If no intrusion of growth into the bronchus can be visualized, one may observe evidences of infiltration of the bronchial wall, namely, fixity and rigidity. It must be borne in mind, however, that the bronchoscopist can examine and explore only the larger bronchi, no opinion can be given concerning the smaller bronchial subdivisions. One would, therefore, secure little or no information from bronchoscopy in cases of peripheral cancer, in lobar atelectasis, however, the location and nature of the obstruction could be readily visualized.

Data concerning the anatomical location of primary bronchial carcinoma vary greatly, observers reporting from 35 to 75 per cent of growths as having their origin in the larger bronchi. The number of cases of carcinoma diagnosed positively by bronchoscopy and biopsy also varies—obviously, this depends upon the type of case selected for bronchoscopic study. If performed in cases of atelectasis or in advanced carcinoma only, the number of positive diagnoses would be nearly 100 per cent. If, however, one examines routinely all suspected cases of newgrowth, the number of positive diagnoses is considerably less. At the Bronchoscopic Clinic, of a group of 143 cases of primary carcinoma of the bronchus proven by examination during life or at autopsy, 98 were diagnosed positively by bronchoscopy and biopsy. In three cases an exploratory thoracotomy was performed and tissue secured. Five were diagnosed as pulmonary abscess and drained surgically. Carcinoma was discovered at operation or by biopsy of tissue from the cavity. In 23, newgrowth was strongly suspected from the bronchoscopic findings of bronchial stenosis with fixation and rigidity of the bronchial wall—no biopsy was secured. The diagnosis of cancer ultimately was made either by repeated bronchoscopic examination or at autopsy. In 14, the bronchoscopic findings were inconclusive and the diagnosis of cancer finally was made at autopsy. In the cases proven by bronchoscopy, the growths originated in the

larger bronchi and were readily accessible for inspection and biopsy.

In those cases without intrusion of growth into the larger bronchi, repeated bronchoscopies will ultimately lead to a positive diagnosis. Metastases also will give conclusive information. If the factor *time* is not taken into consideration in arriving at a diagnosis of cancer, then the most conclusive diagnostic method would be a postmortem examination. However, if one considers carcinoma of the bronchus from the standpoint of surgical extirpation, delay in diagnosis cannot be endured.

Of the group of 143 cases observed, not more than five could have been considered as suitable for surgical treatment at the time bronchoscopy was done. This conclusion was arrived at on the basis of the location and extent of the growth and the age of the patient.

Lung Mapping—The employment of iodized oil (40 per cent) to visualize the bronchi is of value in those cases in which no conclusive information can be secured by bronchoscopy. This diagnostic aid cannot supplant bronchoscopy if it is possible to visualize the lesion endoscopically. These usually are cases of upper lobe lesions or peripheral tumors which cannot be visualized by direct examination. Retained secretions in the smaller bronchi may interfere with proper filling and be a source of error.

Comment—Collected data concerning cases of carcinoma of the bronchus show conclusively that the diagnosis is commonly made late in the disease when surgical treatment can no longer be considered. In a large number, probably a majority of these, the diagnosis could have been made early if there had been an opportunity to carry out all of the recognized diagnostic procedures. The clinician should consider bronchial carcinoma as a diagnostic possibility and should carefully interpret the early symptoms, such as cough without or with sputum, blood-streaking, pain, and wheeze. The symptoms of advanced disease should not be waited for. Radiographic studies should be secured early.



Fig 2 Roentgenograms made in the case of a man, aged 48 years who complained of cough of one year's duration. Recently there had been expectoration and pain over the lower chest in the midline. The roentgen appearances suggested an inflammatory process although neoplasm could not be ruled out. At bronchoscopy there was found a pale granular mass obstructing an inner subdivision of the right lower lobe bronchus. Tissue secured was reported as squamous carcinoma by Dr B L Crawford. (Films by Dr R Manges Smith.)

necessarily be a cause for pessimism. If one will recall that prior to 20 years ago a majority of cancers of the lung were diagnosed in the autopsy room, one should be optimistic. Difficulty in diagnosis is met with in the group of cases in which the findings are suggestive of tuberculosis, pneumonitis, bronchiectasis, or pulmonary abscess without roentgenographic evidences of tumor or bronchial obstruction (Fig 2). In these, one must exhaust all of the diagnostic means at hand to bring the case to a final diagnostic conclusion.

Since over 50 per cent of primary bronchial neoplasms originate in the larger bronchi, it is evident that in many during the early stages there is partial obstruction to a bronchus, with obstructive emphysema. It should be recalled that one cannot always demonstrate partial obstruction of a bronchus by the examination of stereoroentgenographic films, which

usually are made at the end of full inspiration. Roentgenoscopic examination of the chest and a study of the films made at the end of full inspiration and expiration aided greatly in the recognition of non-opaque foreign bodies in the bronchus and a knowledge of the mechanism of obstructive emphysema. Such a plan of study should be employed routinely in the examination of suspected cases of early primary carcinoma of a bronchus before the growth has progressed to complete bronchial obstruction with atelectasis.

Bronchoscopy—"Next to its usefulness in the removal of foreign bodies from the air passages, bronchoscopy has developed its greatest value in the diagnosis of malignancy of the lung" (8). Bronchoscopy is the most definite and positive diagnostic procedure available. One may obtain a direct endoscopic view of the growth, in addition, tissue may be secured for histo-

logic examination. If no intrusion of growth into the bronchus can be visualized, one may observe evidences of infiltration of the bronchial wall, namely, fixity and rigidity. It must be borne in mind, however, that the bronchoscopist can examine and explore only the larger bronchi, no opinion can be given concerning the smaller bronchial subdivisions. One would, therefore, secure little or no information from bronchoscopy in cases of peripheral cancer, in lobar atelectasis, however, the location and nature of the obstruction could be readily visualized.

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In those cases without intrusion of growth into the larger bronchi, repeated bronchoscopies will ultimately lead to a positive diagnosis. Metastases also will give conclusive information. If the factor *time* is not taken into consideration in arriving at a diagnosis of cancer, then the most conclusive diagnostic method would be a postmortem examination. However, if one considers carcinoma of the bronchus from the standpoint of surgical extirpation, delay in diagnosis cannot be endured.

Of the group of 143 cases observed, not more than five could have been considered as suitable for surgical treatment at the time bronchoscopy was done. This conclusion was arrived at on the basis of the location and extent of the growth and the age of the patient.

Lung Mapping—The employment of iodized oil (40 per cent) to visualize the bronchi is of value in those cases in which no conclusive information can be secured by bronchoscopy. This diagnostic aid cannot supplant bronchoscopy if it is possible to visualize the lesion endoscopically. These usually are cases of upper lobe lesions or peripheral tumors which cannot be visualized by direct examination. Retained secretions in the smaller bronchi may interfere with proper filling and be a source of error.

Comment—Collected data concerning cases of carcinoma of the bronchus show conclusively that the diagnosis is commonly made late in the disease when surgical treatment can no longer be considered. In a large number, probably a majority of these, the diagnosis could have been made early if there had been an opportunity to carry out all of the recognized diagnostic procedures. The clinician should consider bronchial carcinoma as a diagnostic possibility and should carefully interpret the early symptoms, such as cough without or with sputum, blood-streaking, pain, and wheeze. The symptoms of advanced disease should not be waited for. Radiographic studies should be secured early.

The roentgenologist should be conversant with the clinical history and the symptoms. Examination of the chest should include a study for obstructive emphysema.

The bronchoscopist should be given an opportunity to investigate endoscopically all cases of obstructive emphysema or obstructive atelectasis. Unexplained cough, hemoptysis, and wheeze also warrant bronchoscopy. Iodized oil instillation should be employed as a supplementary aid. Above all, there should be close cooperation between the clinician, roentgenologist, and bronchoscopist. In cases with unexplained pathologic findings, the thoracic surgeon should be consulted.

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DISCUSSION

DR LEO G. RIGLER (Minneapolis, Minn.) Dr Clerf has presented in clear and concise form the picture of the present status of carcinoma of the bronchus as a medical problem. I can agree thoroughly with all he has said about the vital importance of the early recognition of this disease.

Twenty years ago carcinoma of the bronchus was not our problem. Pathologists even considered it rather rare, and cases which were diagnosed clinically were

very unusual. Ten years ago the diagnosis of carcinoma of the bronchus became a serious problem for the roentgenologist and for the bronchoscopist, but the discussion was largely academic because very little was done about it after the diagnosis was made.

To-day the successes of thoracic surgery, which Dr Clerf has mentioned, make the positive diagnosis exceedingly important, and with the work of Dr Clerf and his associates and other work that has been done, we are improving tremendously in our ability to recognize these lesions earlier.

But with this active surgery, a new responsibility and a new problem have presented themselves to us. Whereas before we were largely concerned with the failure to diagnose bronchogenic carcinoma, to-day we may well be concerned with false positive diagnoses, because they may result in drastic surgery which, as all of you know, entails a very serious risk.

In most cases amenable to bronchoscopy, error should occur very rarely. On the other hand, as Dr Clerf has said, there are cases which are not amenable to bronchoscopy and in which the clinical and roentgenologic findings must decide the diagnosis. In those cases, great care must be exercised so that false positive diagnoses shall not be made.

I would like to show just two cases, merely by way of illustration of this point. In the first one, resection of the rib for empyema was made on this boy before we saw him. He came in with a condition which we interpreted as atelectasis with an obstruction of the lower lobe bronchus. He was bronchoscoped and the bronchoscopist thought that there was tumor tissue in that lower lobe bronchus. Biopsy was made and a diagnosis of carcinoma was obtained from the pathologist. Eventually this was proved to be false and further examination of the tissue indicated its inflammatory nature.

This is not a unique case. There are any number of them that have been reported throughout the country. Fortunately for this boy, the circumstances were

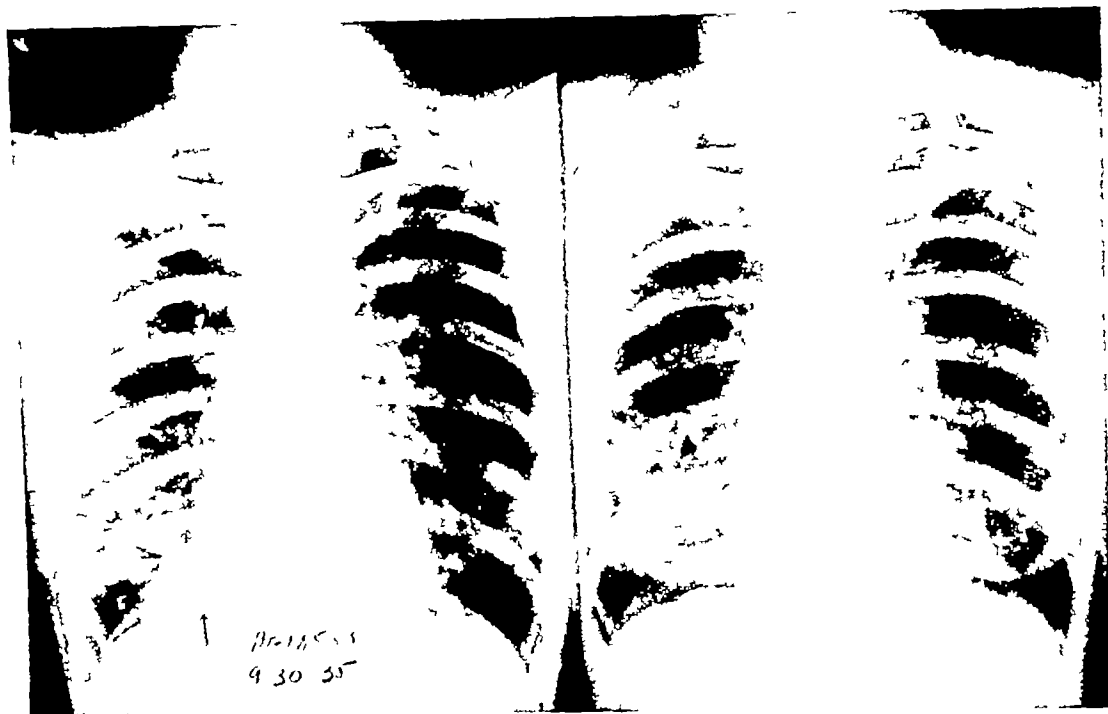


Fig 1

Fig 2

Fig 1 Roentgenogram of chest made Sept 30 1935 with consolidation at right base which had been increasing in size for months. Clinical and roentgen studies were suggestive of peripheral bronchogenic carcinoma.

Fig 2 Same case two months later with almost complete spontaneous resolution indicating error in diagnosis. Residue of iodized oil in alveoli is also shown.

such that no effort at surgery was made, but I call attention to it because of the possibility of that type of error occurring. The histologic diagnosis of the bronchial mucosa is not an easy one and it takes a very experienced pathologist, experienced in that particular type of histological diagnosis, to be certain as to his findings. Another film on the same boy a little later, when the bronchus had been opened up and we were able to fill it with iodized oil below the obstruction, demonstrated the typical dilatation which had occurred. It is about five years since that time and he is still alive.

This next case is of a somewhat different type. This was a woman sent in to a tuberculosis sanatorium because of blood-streaked sputum—a diagnosis of tuberculosis had been made. She was studied there over a period of three months. When she first came in to the sanatorium there was a small density in the cardio-

phrenic angle, very small, perhaps one-third the size of the density which you see in this slide. This was shown in the lateral view to be quite peripheral, in the posterior portion of the lower lobe (Fig 1).

That area of consolidation grew under our very eyes over a period of about three months during which she had all the symptoms which suggested carcinoma. She was sent in to our hospital, the lesion having attained this size. Being very peripheral, the bronchoscopy was negative, but we considered that of no significance. We felt she had a carcinoma of the peripheral type—a type ideal for treatment. Surgery was recommended but, fortunately for her and for us, she refused it and three months later the lesion had disappeared completely as shown in Figure 2. No doubt this was some type of atypical pneumonia. The woman is perfectly well now.

I cite these two cases to show that some

of these early diagnoses may lead us very far astray

DR H W JACOX (Pittsburgh) May I ask Dr Clerf what he does in these cases that he speaks of, the early ones in which the x-ray findings are not very definite, in regard to treatment? In most cases I see, my opinion is asked and I should like to know whether he uses surgical diathermy in these early ones to avoid the serious risk of radical surgery or whether he uses radon seeds. What is his present opinion in regard to treatment—to be as con-

servative as possible and yet get rid of the cancer?

DR CLERF (closing) There is no conservative treatment of carcinoma of the bronchus. For a time we believed that destroying the growth by bronchoscopic fulguration would be effective, but a cure by this means would be a curiosity. Unless irradiation therapy can cure these cases, then there is but one plan of treatment, namely, surgical extirpation. If this cannot be practised, the case is hopeless.

PRIMARY BRONCHIAL CARCINOMA AND PULMONARY METASTASIS COMPARED CLINICALLY AND ROENTGENOLOGICALLY¹

By JOHN T. FARRELL, JR., M.D., *Philadelphia*

From the X-ray Department of the Jefferson Hospital

THE increasing occurrence of primary bronchial carcinoma and the high incidence of metastasis to the lungs makes a comparison of the two conditions of interest. In 1934 the author presented before this Society a study of 78 cases of pulmonary metastasis discovered at necropsy at the Jefferson Hospital in the ten-year period from November, 1924, to November, 1934 (1), and in 1935 a study of 50 cases of primary bronchial carcinoma in which the diagnosis was made by histologic examination of tissue removed from the tumor (2). This presentation is based on re-examination of the material and a comparison of primary and metastatic pulmonary malignancy as to the age and sex of the patients, the initial and general symptomatology, the roentgen signs, the duration and the prognosis.

Histologic Classification—Of the primary group, 23 (or 46 per cent) were classified as squamous-cell carcinoma, three (or 6 per cent) as adenocarcinoma, and 24 (or 48 per cent) as undifferentiated carcinoma.

The metastatic tumors were secondary to carcinoma in 61 (or 78 per cent), to sarcoma in 12 (or 15.3 per cent), to melanoma of the skin in two (or 2.4 per cent), and to an endothelioma of the pleura, a teratoma of the testicle, or a thymic tumor in one (or 1.2 per cent) each.

Sex (Table I)—Of the primary carcinomas 45 (or 90 per cent) occurred in males and but five (or 10 per cent) in females. This is in accord with the findings of other observers.

In the metastatic group 53 (or 67.9

per cent) occurred in males and 25 (or 32.1 per cent) in females. While there is still a much higher incidence in the male, the ratio is reduced from two-to-one as compared with the nine-to-one ratio in the primary group. The explanation of the preponderance of males is not clear, for of the 61 cases of metastatic carcinoma, seven (or 11.4 per cent) were secondary to cancer of the breast in which the incidence in women is much greater than in men. However, the incidence of metastasis of cancer peculiar to women is offset by the higher rate of metastasis to the lungs from primary tumors of the generative organs in males, seven (or 11.4 per cent) were primary in the prostate or testicle as against one (or 1.6 per cent) from the ovary.

TABLE I—COMPARISON OF PRIMARY AND METASTATIC PULMONARY MALIGNANCY
AGE-SEX DISTRIBUTION

	Primary (50 Cases)		Metastatic (78 Cases)	
	No.	Percent- age	No.	Percent- age
1-10			1	1.2
21-30	4	8	6	7.6
31-40	9	18	11	14.1
41-50	16	32	21	26.9
51-60	15	30	21	26.9
61-70	6	12	10	12.8
71-80			7	8.9
81-90			1	1.2
Males	45	90	53	67.9
Females	5	10	25	32.1

Age (Table I)—As one would expect, the highest age-incidence is found in the so-called "cancer age" which occurs after 40 years. This is true in this series 31 (or 62 per cent) of the primary growths and 42 (or 53.8 per cent) of the metastatic lesions were in patients between 40 and 60 years of age. In the extremes of age, however, the metastatic group showed

¹ Read before the Radiological Society of North America at the Twenty-second Annual Meeting at Cincinnati, Nov. 30-Dec. 4, 1936.

the higher incidence, one tumor was in a patient 20 years of age and eight (or 10.1 per cent) occurred in individuals over 70, whereas, in the primary tumors 46 (or 92 per cent) occurred in patients between the ages of 20 and 70 years. This is probably due to the fact that tumors of the urogenenerative organs, responsible for 17 (or 27.7 per cent) of the cases of metastatic cancers, occur relatively late in life.

Symptomatology (Table II)—The striking difference in the two groups is in the incidence of pulmonary symptoms. It would be expected that some form of respiratory symptom due to local bronchial irritation would occur in the primary tumors and that all patients would complain of one or more. This is true. One might also expect that in metastasis respiratory symptoms would occur, but, as a matter of fact, they are not prominent.

TABLE II—COMPARISON OF PRIMARY AND METASTATIC PULMONARY MALIGNANCY SYMPTOMS

	Primary (50 Cases)		Metastatic (78 Cases)	
	No.	Percent- age	No.	Percent- age ²
Cough	49	98	15	42.8 (2)
Expectoration	34	68	6	17.1 (4)
Pain	30	60	9	25.7 (3)
Dyspnea	27	54	23	65.7 (1)
Loss of weight	26	52		
Hemoptysis	24	48	6	17.1 (5)
Elevated temperature	14	28		
Wheeze	6	12		
Night sweats	6	12		
Hoarseness	3	6	1	2.8 (6)
Dysphagia	1	2		
None				
Not recorded			37	47.4
			6	7.6

² Determined on basis of 35 cases presenting respiratory symptoms

It was definitely stated in the histories of 37 (or 47.4 per cent) of the patients with pulmonary metastasis that there were no local respiratory symptoms, and in six (or 7.6 per cent) neither the presence nor the absence of symptoms were recorded. It may be assumed from this that they were not present, indicating

that of the 78 patients only 35 (or 45 per cent) exhibited local manifestations.

Cough, expectoration, pain in the chest, dyspnea, hemoptysis, and wheeze were the most frequently encountered local symptoms of the primary group. Dyspnea, cough, pain, and expectoration, in that order, were the most prominent local symptoms of the metastatic tumors.

Wheeze and dyspnea are worthy of special comment. The importance of wheeze as a symptom of onset in primary bronchial growth has been pointed out by Clerf (3). Its importance is not generally recognized. In this series it was recorded as being present in only six (or 12 per cent) of the patients, but in the histories of the remaining 44 (or 88 per cent) of the group, it was not mentioned as being present or absent, indicating that it was not sought for routinely. If in every instance the patient had been questioned as to wheeze, the incidence would undoubtedly be much higher, because with extension of the growth after its onset wheeze is masked, cough and expectoration, because of the distress they cause the patient, becoming the prominent features.

Dyspnea was the most frequent complaint of the 35 of the 78 patients with metastasis who had pulmonary symptoms. It occurred in 23 (or 65.7 per cent) of the cases. This is in contrast to its incidence in the primary group in which it occupied the fourth place, cough, expectoration, and pain all being recorded more frequently. The higher incidence in metastasis is probably due to the massive pleural effusions secondary to pleural metastasis which so often accompany pulmonary metastases.

Duration and Prognosis (Table III)—The ultimate fate of all patients with primary bronchial tumors is not known, and comparison as to the duration of life with that of the metastatic group cannot be made. However, the interval between the onset of the first symptom and the first medical examination in the

primary group, and the interval between discovery of the primary tumor and death in the metastatic group, are known and furnish a basis for comparison

Tumors which metastasize to the lungs are more rapidly fatal than are primary bronchial growths. The finding of pulmonary metastasis is a grave prognostic sign

TABLE III—COMPARISON OF PRIMARY AND METASTATIC PULMONARY MALIGNANCY DURATION

Primary (50 Cases) (Time Interval from Onset to First Medical Examination)	Percent-		Metastatic (78 Cases) (Time Interval from Discovery of Pri mary Tumor to Death)	Percent-	
	No	age	No	age	
1-6 months	14	28	35	44	8
6-12 months	9	18	16	20	5
1-2 years	15	30	10	12	8
2 years and more	8	16	7	8	9
Indeterminate	4	8	10	12	8

Of the patients with pulmonary metastasis, 55 (or 65.3 per cent) died in less than a year from the time of discovery of the primary tumor. It should be borne in mind that duration of life is reckoned from the finding of the causative tumor and not from the time of recognition of the metastasis. In contrast with this, it could be determined that 23 (or 46 per cent) of the patients with primary bronchial tumors had endured the initial symptom for more than a year before they first sought medical advice as to the cause of the symptom. In many instances it took again as long before the diagnosis of the etiologic factor was finally made by histologic examination of tissue removed at bronchoscopy.

Roentgen Characteristics (Table IV)—In the primary tumors indications of collapse of a lobe or a portion of a lobe was the most frequently encountered roentgenologic sign. It occurred in 20 (or 40 per cent) of the cases. Then followed increased linear markings in 14 (or 28 per cent), mass in 12 (or 24 per cent), abscess in three (or 6 per cent), and pleural effusion in one (or two per cent).

The diagnosis of primary bronchial carcinoma can rarely be made by roentgen examination alone, though when atelectasis is found in adults with respiratory symptoms of protean character the examiner should be strongly suspicious of bronchial neoplasm and advise the bronchoscopic removal of a piece of tissue for histologic examination.

TABLE IV—COMPARISON OF PRIMARY AND METASTATIC PULMONARY MALIGNANCY ROENTGENOLOGIC CHARACTERISTICS

Primary	Metastatic
Atelectasis	Nodule { Number Outline Density Distribution Size
Increased linear markings	
Mass tumor	
Abscess	
Pleural effusion	

The shadow of the nodule is pathognomonic of metastasis. Nodules rarely occur in the lungs in other conditions. The shadows of the nodules present the same characteristics that the nodules do on gross morbid examination. They are usually round, sharply circumscribed shadows of which there may be either only a few or an innumerable number. They range in size from a few millimeters to several centimeters, and may occur in a limited portion of one lung or be scattered throughout both lungs from apices to bases. They range in density from faint nebulous shadows to densely opaque masses. Complications alter the roentgenologic appearance of both the primary and metastatic growths. In the primary growth necrosis of the center, with abscess formation, is frequent. In metastasis there is a high incidence of pleural effusion which, in many instances, hides the characteristic metastatic nodules.

CONCLUSIONS

Comparison of 50 cases of histologically proven bronchial carcinomas with 78 cases of metastatic pulmonary malignancy proven by necropsy indicate that

1. Primary pulmonary malignancy has a greater incidence in males than metastatic malignancy. In the primary cases 90 per cent were males and 10 per cent

females, in the metastatic group 68 per cent occurred in males and 32 per cent in females

2 Both primary and metastatic malignancy occur most frequently between 40 and 60 years of age, but before 20 years and after 70 years the incidence of metastatic malignancy is greater than that of primary

3 In primary malignancy respiratory symptoms were much more marked than in metastasis, in 98 per cent of the patients with primary carcinoma there were respiratory symptoms, whereas, in the metastatic only 45 per cent had local manifestations

4 Wheeze is a frequently overlooked important initial symptom of primary bronchial neoplasm

5 The discovery of pulmonary metastasis is graver than the discovery of primary bronchial malignancy, 65 per cent of the patients with pulmonary metastasis died within a year of the finding of the causative tumor, while 46 per cent of those with primary bronchial carcinoma endured the initial symptom for a year before they sought medical advice

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DISCUSSION

DR JOHN D CAMP (Rochester, Minn) After Dr Clerf's comprehensive paper, Dr Rigler's discussion, and Dr Farrell's paper which Dr Clerf has kindly read, there is little left to be said concerning this subject

There are a few points, however, in the text of Dr Farrell's paper which might bear comment

In the first sentence Dr Farrell refers to the increasing occurrences of primary bronchial carcinoma Personally, I am not convinced that bronchial carcinoma is increasing in incidence I still think, al-

though somebody might like to argue this with me, that the apparent increasing incidence is due rather to our increasing diagnostic accuracy, improvement in clinical methods, and familiarity with the symptoms

Dr Clerf mentioned the significance of the occurrence of a wheeze in bronchial carcinoma and its absence in metastatic lesions He has referred to this, I believe, in the past and perhaps this sign has not been appreciated as much as it should be I think that if we all interrogated these patients more carefully, we might find this sign very helpful in the differential diagnosis

There is one significant point which these figures bring out (I am sorry that Dr Farrell didn't break down these figures, because I am sure they would be of interest to those who like cancer statistics) That is, that 65 per cent of the patients with pulmonary metastases died in less than one year from the time of discovery of the primary tumor It would be interesting to know what types of malignancy these were Perhaps Dr Clerf can help us on that point However, if 65 per cent of patients die within a year of the recognition of the initial lesion, there is a lot to be thought of here in regard to improving our therapy

In regard to roentgen characteristics, the matter of atelectasis has been commented upon and the difficulty of recognizing any characteristic roentgenographic sign of primary malignancy has been brought out Here, I think, is well shown the necessity for close co-operation between the radiologist and the clinician in appraising the significance of many of the shadows which we see in the roentgenogram

Dr Farrell mentioned the significance of the nodule in the diagnosis of metastatic lesions That is true, particularly, when they are multiple However, when we have a single nodular lesion, which is not common but which is not truly rare, the distinction between a benign neoplasm, an inflammatory lesion, and a primary parenchymal malignancy may be exceedingly

difficult because some of these nodular primary malignancies may be peripherally located and not accessible to bronchoscopic examination

When a primary malignant nodular lesion undergoes cavitation, we may have considerable difficulty in differentiating it from an inflammatory lesion with cavitation. Personally, I think the thickness of the wall of a cavity may help one a little, and in my experience primary malignancy with cavitation has been associated with thicker and more irregular walls than inflammatory lesions, with cavitation

One last point I would like to emphasize—that is the necessity of making films of the thoracic spine in all cases of tumor masses in the posterior mediastinum. We know that a neurofibroma may be primary within the chest but a fair percentage of intraspinal neurofibromas (25 per cent of our last series) may protrude through an intervertebral foramen into the posterior mediastinum. The chest film may suggest a solitary intrathoracic mass. However, enlargement of an intervertebral foramen and erosion of the contiguous vertebral pedicle indicate the intraspinal origin of the tumor. In these conditions it is helpful to know that the lesion is both intraspinal and intrathoracic because the surgical approach must be adapted accordingly

DR CLERF (closing) Answering Dr Camp's inquiry concerning the tumors of the metastatic group, I can say only that a large number were sarcomas and that about 28 per cent of all the metastatic tumors originated from tumors of the urogenital organs

Concerning the question of an actual increase in the incidence of bronchial tumors it seems that there are more cases now than formerly, irrespective of improved diagnostic methods. Probably one factor is the increased expectancy of life

Wheezing respiration often is overlooked both by the patient and the physician. Many patients are not aware that they are wheezing until their attention is directed to it by the family or friends. Recently a patient with partial bronchial obstruction produced by cancer, and with wheezing respiration, was admitted to the Bronchoscopic Clinic for study. I asked him if he had ever noticed a wheezing sound when he breathed and he replied in the negative. Had he been admitted after bronchial obstruction became complete the wheeze would have been absent. The patient very probably would have replied in the negative to any inquiry concerning wheezing

Theoretically, every patient with partial bronchial obstruction should wheeze at some time

ROENTGENOGRAPHIC UNSHARPNESS OF THE SHADOW OF A MOVING OBJECT¹

By S REID WARREN, JR., *Philadelphia*

From the Moore School X-ray Laboratory, Moore School of Electrical Engineering,
University of Pennsylvania

INTRODUCTION

THE shadows of the heart and of the parenchyma of the lungs are unsharp, or blurred in chest roentgenograms. The greatest part of this unsharpness is commonly attributed to three phenomena

- 1 Roentgen rays emanate from a finite area, the roentgen-ray tube focal spot (geometric unsharpness)
- 2 The roentgenographed objects move during the roentgen-ray exposure (unsharpness due to motion)
- 3 Roentgen-ray films and intensifying screens produce unsharpness due to the characteristics of the materials of which they are made

Roentgenographic unsharpness has been studied by Bouwers (1), Bronkhorst (2), Chantraine (3), Zuppinger (4), and others

Bouwers has expressed the geometric unsharpness and the unsharpness due to motion in terms of the exposure time for a given roentgenographic technic. He has then shown that the arithmetic sum of these two unsharpnesses may be minimized uniquely by the usual process of differentiation. The results may be stated in this form: There is one and only one exposure time which will produce minimum "total unsharpness"² for a given roentgenographic

exposure energy, tube rating, and velocity of the roentgenographed object. His work is summarized in the form of curves for particular practical conditions. Bouwers notes that the optimum exposure times which he calculates depend upon the characteristics of the roentgen-ray films and intensifying screens which are used. As the speeds of these auxiliary materials are increased by improved manufacturing methods, the exposure times for minimum "total unsharpness" decrease.

Bouwers shows in one of his papers (1) that if the unsharpness due to intensifying screens may be added arithmetically to "total unsharpness," then there are definite criteria, which depend upon the unsharpness due to intensifying screens and the intensification factor, to determine whether or not screens should be used. He concludes that under the present conditions so long as the velocities of motion of the parts to be roentgenographed are of the order of a few millimeters per second, and so long as the intensifying screens are of the type generally available at the present time, then the use of screens results in the production of smaller unsharpness than the use of technics without screens.

Certain results which are derived below from the geometric aspects of the roentgenographic problem lead to the conclusion that the unsharpness due to motion and the geometric unsharpness are not arithmetically additive. It may be shown in fact that a shadow for which geometric unsharpness is λ millimeters appears to have the same unsharpness as a shadow which has a "total unsharpness" of 2λ millimeters, of which λ millimeters represents geometric unsharpness and λ millimeters represents unsharpness due to

¹ The Moore School X-ray Laboratory has been organized at the University of Pennsylvania under grants by the National Tuberculosis Association. The material contained in this paper has been submitted to the Moore School of Electrical Engineering as part of the requirements which are prerequisite to the awarding of the degree of Doctor of Science in Electrical Engineering.

² Throughout this paper the "total unsharpness" (with the quotation marks for emphasis) represents the arithmetic sum of the unsharpness due to motion and the geometric unsharpness.

motion It is the purpose of this paper to present in broad outline methods by which the geometric unsharpness and the unsharpness due to motion may be combined to obtain a measure of the observed unsharpness³

The unsharpness due to intensifying screens has also been studied by Chantraine (3) and others It has been concluded that the unsharpness due to intensifying screens is of the order of 0.1 millimeter to 0.3 millimeter The results of this investigation show that if the unsharpness due to intensifying screens is of the order of 0.1 millimeter to 0.3 millimeter, as measured by Chantraine, then this unsharpness may be an important contribution to observed unsharpness in roentgenograms made with intensifying screens Therefore, although the effects of the unsharpnesses produced by intensifying screens and x-ray films are not considered in this paper it should be recognized that the study of these effects is necessary for the complete analysis of unsharpness of clinical roentgenograms These effects will be studied by methods like those described in this paper and the results combined with the results which are presented below It should be emphasized, therefore, that precise clinical applications of the results obtained in this paper require further investigation of associated problems⁴

The unsharpness due to x-ray film has been shown to be smaller in practice than any of the contributions to unsharpness described above The effect of unsharpness due to x-ray film is, therefore, neglected throughout this paper

³ Throughout this paper the observed unsharpness represents the observed width in millimeters of the shadow of an object which moves parallel to the x-ray film during exposure after the film has been processed and is examined by means of a film illuminator The observed unsharpness in this paper refers to shadow borders obtained without the use of intensifying screens or with the use of intensifying screens if the unsharpness due to the screens may be neglected

⁴ Also note on page 464 that clinical application depends upon further study of the motion of roentgenographed objects as for example the motion of the heart and the parenchyma of the lung

The investigation of roentgenographic unsharpness which is described herein comprises

- I The calculation of the roentgenographic unsharpness without intensifying screens of the shadow of a plane object moving with constant velocity parallel to the plane of the roentgen-ray film
- II The description of experiments performed in order to test the results of the calculations of I
- III The deduction of tentative criteria for minimum observed unsharpness in chest roentgenograms These criteria are tentative since further data are required for their precise calculation
- IV Problems which must be solved in order that the results of I and II may be used to obtain precise criteria for minimum observed unsharpness in clinical roentgenograms

I THE CALCULATION OF ROENTGENOGRAPHIC UNSHARPNESS

An x-ray tube is mounted at a distance $(a + b)$ centimeters from an x-ray film A plane of x-ray absorbing material is mounted at a distance b centimeters from the x-ray film and this object may be moved parallel to the x-ray film with constant velocity The planes of the object and film are parallel Figure 1 represents these devices in diagrammatic form The x-ray tube focal spot f , the object o , and the film F The heavy lines in Figure 1 are the traces on the plane of the paper of the effective focal spot, the object, and the film The remaining lines are geometric constructions to be discussed below⁵

It should be noted that the distances a , b , f , etc., are not drawn to scale in

⁵ In actual practice the trace of the focal spot would not of course be perpendicular to the line $f_o x_o$. However the length f having been defined as the length of one side of the effective focal spot of a line focus tube the resultant calculations will be accurate to a high degree of approximation and the calculations are greatly simplified by this procedure

Figure 1 Actually in roentgenographic work the distances are on the average of the orders of magnitude given below

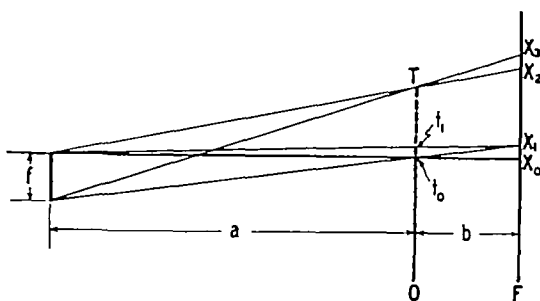


Fig 1 Schematic diagram *not drawn to scale* of the trace f of the effective focal spot of a roentgen ray tube the trace O of a plane object which moves with constant velocity v cm. per second in the direction $t_o T$, and the trace F of a plane x -ray film A perspective view of the experimental apparatus is shown in Figure 5

(1) The length a is of the order of 10*b*,
(2) the side of the square effective focal spot f is of the order of 0.003*a*, (3) the distance travelled by the object edge during the roentgen-ray exposure is always less than 0.01*a*, and in clinical routine it is usually of the order of 0.002*a*

During roentgen-ray exposure the phenomena are assumed to proceed as follows At the instant t_o the edge of the object o intersects the line $x_o t_o$ (Fig 1) The object moves with constant velocity v centimeters per second from t_o to T At the time t_o a roentgen-ray exposure of constant intensity begins This exposure continues until time T when the object edge has arrived at the point T The focal spot f then stops emitting roentgen rays The object edge therefore travels vT centimeters during the constant intensity roentgen-ray exposure

If all distances are measured in centimeters, the following geometric relations may be derived from Figure 1 and the description of the experiment described above

$$x_1 = \frac{bf}{a}$$

$$x_2 = \frac{a+b}{a} vT$$

$$v t_1 = \frac{bf}{a+b}$$

$$x_3 - x_2 = x_1 = \frac{bf}{a}$$

During exposure the roentgen-ray intensity at points on the film above x_1 is I , the characteristics of the object are supposed to be such that during the exposure the intensity at points below x_o is I_o , the total exposures above x_1 and below x_o are, therefore, IT and $I_o T$, respectively Using the symbol E for total exposure, these facts may be summarized

$$E_x = IT \quad (x > x_1)$$

$$E_x = I_o T \quad (x < x_o)$$

The following method is used to calculate the exposure E_x for points lying between x_o and x_1 , i.e., within the band of border unsharpness Note that in most earlier papers on this subject $x_1 = \frac{bf}{a}$ is called the "geometric unsharpness", $x_o = \frac{a+b}{a} vT$ is called the "unsharpness due to motion," and $x_3 = x_1 + x_2$ is called the "total unsharpness"

Consider first the region from $x_o = 0$ to $x_1 = \frac{bf}{a}$ Designate distances measured in this region from $x_o = 0$ by the symbol α At $\alpha = 0$ the intensity at $t_o = 0$ is I_o and is constant during the exposure Therefore, as described above

$$E_{\alpha=0} = I_o T$$

At $\alpha = x_1$ the intensity at time $t = 0$ is I The intensity at this point decreases linearly with the time to I_o at time $t_1 = \frac{bf}{v(a+b)}$ The intensity is constant and equal to I_o from time t_1 to time T This is shown graphically in Figure 2 in which the roentgen-ray intensity upon the film at x_1 is i_{x_1} at any time t

The total exposure E_{x_1} is

$$E_{x_1} = \int_0^T i_{x_1} dt = \frac{bf}{2v(a+b)} (I - I_o) + I_o T$$

For any α between $\alpha = 0$ and $\alpha = x_1$, the initial intensity (at $t = 0$) is a fraction of I given by

$$i_{\alpha} = \frac{a}{bf} \alpha I + \left(1 - \frac{a}{bf}\right) I_o$$

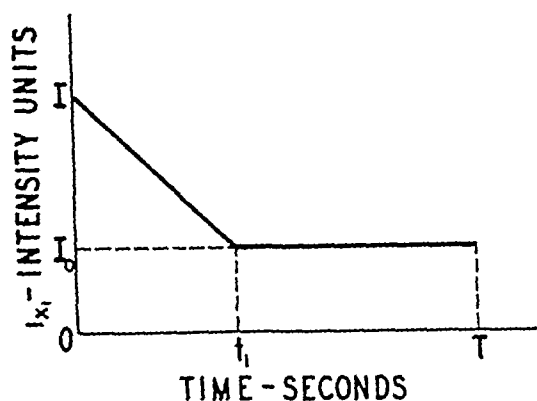


Fig 2 A graphical representation showing how the roentgen ray intensity i_{x1} along a strip of film perpendicular to the plane of the paper at x_1 , Figure 1, varies with time during an exposure of T seconds

The intensity decreases from this initial value to I_0 at time t_α . From t_α to T the intensity is I_0 . The time t_α when the object intercepts the radiation (except I_0) is

$$t_\alpha = \frac{u\alpha}{v(a+b)}$$

During the exposure the intensity at α , therefore, varies as shown in Figure 3

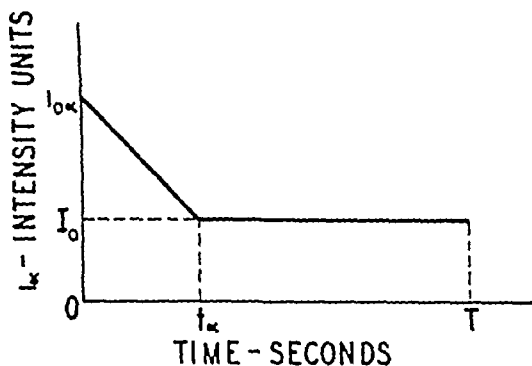


Fig 3 A graphical representation showing how the roentgen ray intensity i_{α} along a strip of film perpendicular to the plane of the paper (Fig 1) between x_0 and x_1 distant α cm from x_0 varies with time during an exposure of T seconds

From the relations given above and from Figure 3, the total exposure at α (where α is measured from x_0) may be calculated

$$E_{\alpha} = \int_0^T i_{\alpha} dt = \frac{1}{2} t_{\alpha} (I_{0\alpha} + I_0) + I_0 T$$

$$E_{\alpha} = \frac{1}{2} \frac{u^2 (I - I_0)}{bfv(a+b)} \alpha^2 + I_0 T \quad (0 \leq \alpha \leq \frac{bf}{u})$$

By this method the total exposures E_{β} and E_{δ} , for points between x_1 and x_2 , and between x_2 and x_3 , respectively, may be calculated from

$$E_{\beta} = \frac{a}{v(a+b)} (I - I_0) \beta + \frac{bf}{2v(a+b)} (I - I_0) + I_0 T \quad (0 \leq \beta \leq x_2 - x_1)$$

$$E_{\delta} = \frac{-a^2}{2bfv(a+b)} (I - I_0) \delta^2 + \frac{a}{v(a+b)} (I - I_0) \delta - \frac{bf}{2v(a+b)} (I - I_0) + I_0 T \quad (0 \leq \delta \leq x_3 - x_2)$$

in which β is measured from x_1 and δ is measured from x_2

Figure 4 shows graphically the variation of E with x for three cases for which the sum $(x_1 + x_2)$ is the same. In Figure 4-A the curve is calculated for $x_1 = x_2$. In this case the first half of the curve is E_{α} , the second half is E_{δ} . The formula for E_{β} is not used, because $x_2 - x_1 = 0$, i.e., β does not exist. Figure 4-B shows the calculation for x_2 twice as large as x_1 . In this case α , β , and δ have equal ranges, i.e., from zero to $\frac{bf}{a}$.

There remains the case where x_2 is very small compared to x_1 . Although this may be calculated in the same manner that E_{α} , E_{β} , and E_{δ} are deduced above, it is simpler to obtain the result in another manner. If x_2 is very small with respect to x_1 the result is similar to that which would be obtained if v were put equal to zero, i.e., if the object were stationary. The curve E vs x for this case is

$$\bar{E}_x = \frac{a}{bf} (I - I_0) T x + I_0 T \quad (0 \leq x \leq x_1)$$

This is shown in Figure 4-C

These curves suggest that the shadow border of Figure 4-A would appear considerably sharper than the borders represented by either Figure 4-B or Figure 4-C, even though the same value of x_3 , the "total unsharpness," is obtained in all cases. Experiments to test this suggestion are described in the next section.

Certain psycho-physiologic factors must be considered when these results are applied to clinical roentgenography. Bronkhorst (2) shows that the unsharpness which

is perceived in a roentgenogram depends not only upon the density of the film throughout the unsharp area, but also upon the contrast between the two areas on either side of the unsharp area. He shows that

II EXPERIMENTAL PROCEDURE

The experimental procedure for testing the theoretical conclusions of Section I consists essentially of an assembly of apparatus like that represented diagram-

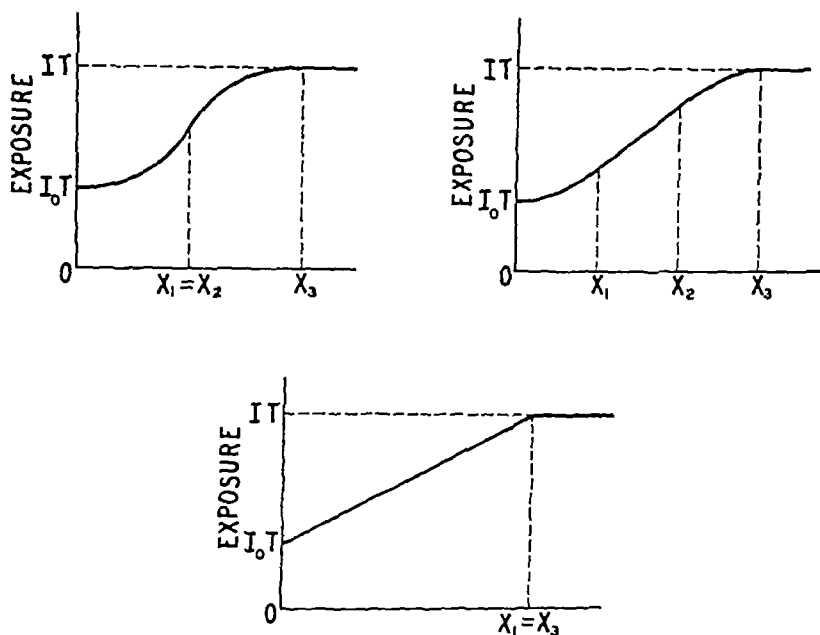


Fig 4 The theoretical variation of roentgen-ray exposure with x measured from x_0 upward (Fig 1) for three cases

Fig 4-a, upper left, $v_1 = 1$ or $\frac{v_2}{v_1} = 1$

Fig 4-b, upper right $\lambda_2 = 2x_1$ or $\frac{v_2}{\lambda_1} = 2$

Fig 4-c lower $\lambda = 0$ or $\frac{\lambda_2}{v_1} = 0$

The sum $(v_1 + \lambda_2)$ is the same in all three cases

this perceived unsharpness is in general less than the unsharpness measured by methods like the one described below. There appears to be a dark line parallel to the unsharp border shadow in the more dense area and a bright line parallel to it in the less dense area. Bronkhorst shows figures in which he has sketched dotted lines to represent observed unsharpness. This point must be thoroughly investigated not only for shadows like those described in this section, but also for unsharp shadow borders having widths equal to those encountered in roentgenographic practice, i.e., 1.5 millimeters or less.

matically in Figure 1. The apparatus actually used is shown in Figure 5 and described in the caption of that figure. The effective focal spot of the x-ray tube is approximately square, the sides 5 millimeters in length. Double coated roentgen-ray film was used for the experiments. Pieces of this film were wrapped in black paper and enclosed in a special bakelite cassette. The front cover of the cassette was made of one-sixteenth inch bakelite. Films were continuously but irregularly agitated during development in commercial elon-hydroquinone developing solution. The apparatus used for these experiments

consisted of a four-valve roentgenographic equipment with a capacity of 100 kv p, 400 ma. X-ray exposures were chosen so that the apparatus operated in a stable, easily controlled manner. The velocities

of the problems described in the introduction to this paper, it will be necessary to show that the conclusions derived from the work given below are applicable in practical cases.

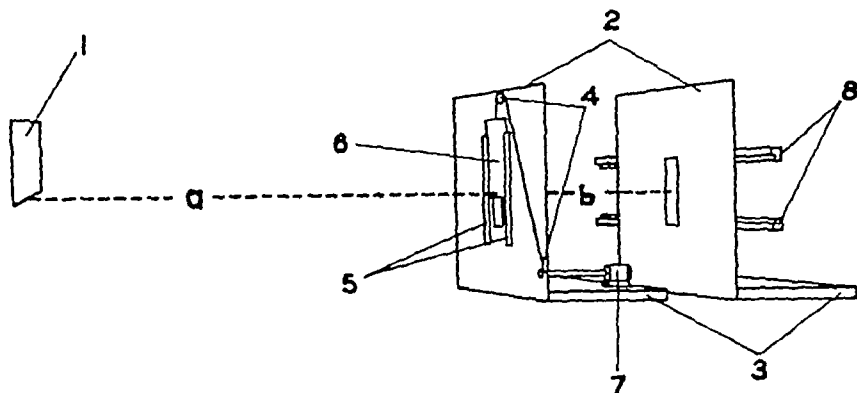


Fig. 5. Perspective drawing of apparatus used in the experiments described in Section II. 1, anode of roentgen-ray tube, 2, lead sheets each having a rectangular aperture at its center, 3, wood base mountings for lead sheets 2, 4, pulleys the lower of which is rotated by means of a synchronous motor 7, 5, brass guides for 6, a sheet of lead which is moved upward over the aperture in lead sheet 2 by means of a silk thread fastened at the top of 6 which runs over the upper pulley 4 and is fastened to the periphery of the lower pulley 4, 7, a synchronous clock motor which drives the lower pulley 4 (attached to its shaft) at a constant angular velocity of one revolution per minute.

of motion, the distances a and b , were chosen arbitrarily for convenience so that the calculated v_1 and v_2 were of the order of magnitude necessary for accurate density measurements as described below. This experimental set-up, therefore, does not exactly simulate conditions obtained in roentgenographic practice. The experimental conditions were chosen for convenience.

In order to make accurate measurements of density the 'total unsharpness' must be of the order of one centimeter. It is, of course, true that the unsharpness obtained in usual roentgenographic procedures seldom exceeds one millimeter and is very often less than 0.5 millimeter. However the conclusions derived from these tests have been further applied to the study of unsharpness of the order of two millimeters. It was shown by these tests that the observed unsharpness is the same for all values of 'total unsharpness' from two millimeters to one centimeter. Nevertheless, after further investigations are made

In order to use an X-ray beam of approximately the same character as that which is incident upon the film in general roentgenography a filter of 3 one-eighth inch discs of aluminum was placed over the aperture in the X-ray tube from which the radiation emanates.

The choice of the exposure time is prescribed by the fact that if the object moves with a very high velocity the pulsations in X-ray intensity due to the X-ray tube voltage wave form will produce striations in the unsharp shadow border. Exposure times and velocities are chosen, therefore, so that these striations are so narrow that they may be neglected. The exposure time for all test films was three seconds.

The experimental procedure may be best illustrated by describing a particular test. It was desired to obtain a roentgenogram for which $v_1 = 0.44$ centimeter and $v_2 = 0.44$ centimeter. It was desired to obtain densities of approximately 0.2 and 1.0 on either side of the unsharp border. It will be noted that it is convenient to choose a

fixed focal spot-film distance for all tests, $1 e$, to make $(a + b)$ constant. In all of the tests the focal spot-film distance was 80 centimeters. Having fixed $(a + b)$ it is necessary to choose a , b , and v so that $\frac{bf}{a}$ is equal to 0.44 and $\frac{a + b}{a} vT = 0.44$.

This results in the use of $a = 43$ centimeters, $b = 37$ centimeters, and $v = 0.075$ centimeter per second. In order to produce the desired densities it was found that the x-ray exposure should be as follows: x-ray tube voltage 54 kv p, product of x-ray tube current and exposure time 90 milliamperes-seconds.

The edge of the lead sheet was approximately three centimeters below the center line of the x-ray beam when the motor was started. As the edge of the lead sheet approached the center line the x-ray exposure was begun. Before and after each test the velocity of motion of the object edge was measured by noting the time required for it to traverse a distance of two centimeters and then calculating the velocity in centimeters per second.

A number of exposures were made using the lead plate as a moving object. Of these the techniques for three were chosen to produce shadows like those in Figure 4. The techniques used for these three films are listed in Table I. It will be noted that the ratios of v_2 to v_1 for roentgenograms 1, 2, and 3 are 1, 2, and 0, respectively. These are precisely the forms shown in Figure 4.

TABLE I

For all films { Roentgen-ray tube voltage = 54 kv p Roentgen ray tube current = 30 ma Exposure time = 3 seconds			
Film Number	1	2	3
a cm	43	50	28.5
b cm	37	30	51.5
v cm/sec	0.075	0.125	0
$x_1 = \frac{bf}{a}$ cm	0.43	0.30	0.90
$x_2 = \frac{a + b}{a} vT$ cm	0.425	0.60	0
$\frac{x_2}{x_1}$	1	2	0

A number of films were made using an aluminum plate in place of the lead plate as

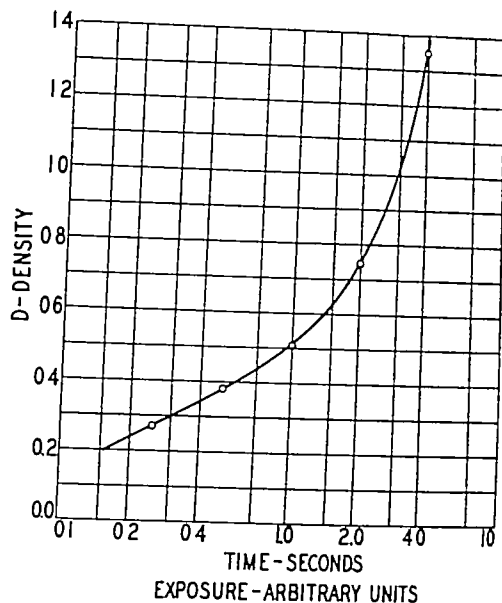


Fig. 6 Density vs exposure characteristic of the particular film used in these tests

moving object. By varying the x-ray tube voltage and the x-ray tube current it is possible to produce any degree of contrast between the two areas of the roentgenogram that may be desired, within the limits normally encountered in roentgenography. Tests of this nature must necessarily be expanded if the methods described in this paper are to be applied to general problems. However, since insufficient data are now available for treating this general problem no attempt is made in this paper to discuss results of the tests using an aluminum plate. It will suffice to note that nothing appears from these preliminary tests to suggest that the conclusions derived from the tests with the lead plate are not generally applicable.

After the films were processed the variation of density along the film parallel to the direction of motion of the object was measured by means of a microdensitometer.⁶ The microdensitometer uses two photoelectric cells. Light from a tungsten

⁶ The author acknowledges the privilege extended to him by Dr. W. F. G. Swann, Director of Bartol Research Foundation of the Franklin Institute, to use the microdensitometer in the Bartol Laboratory, and also the aid of Mr. Lipman, Dr. Swann's associate, for his instruction in the use of the instrument.

filament lamp is split into two beams, one of which impinges upon one of the photoelectric cells. This photoelectric cell is so connected that small changes in light intensity do not affect the readings of the instrument. The second beam is focused upon an area of the film to be measured. This area is approximately one millimeter by one-tenth millimeter, the short dimension lying in the direction v of the test roentgenogram. The light transmitted through the film is reflected into the second photoelectric cell. An electrometer with an illuminated scale reads the difference between the photoelectric cell currents so that its deflection is proportional to the opacity of the film. The sensitivity of the device may be adjusted so that it is possible to cover the entire range of densities of the roentgenograms 1, 2, and 3 described in Table I with one setting of the microdensitometer. The deflection of the electrometer is proportional to the intensity of the light transmitted by the film. The deflection of this instrument was plotted in terms of film density by using a standard neutral gray density tablet. In this manner the instrument was used as a comparative microdensitometer.

Each of the films 1, 2, and 3, described in Table I, was placed⁷ upon the movable table of the microdensitometer in such a manner that it could be moved in the direction v by means of a calibrated control on the densitometer. Density readings were then obtained along the axis of v in steps of 0.5 millimeter. The data for these three test films have been plotted with crosses in Figure 7.

In order to compare these experimental results with those derived theoretically in Section I it is necessary to obtain values for I and I_0 and a curve showing relations between the exposure E and the density D . The characteristics of the film were obtained by exposing five areas of a piece of

⁷ Note that in the experimental procedure (see Fig. 5) the object moves in the sense opposite to that in Figure 1. Films made in these two ways are physically indistinguishable if x_0 and the direction x_0x_1 are properly chosen.

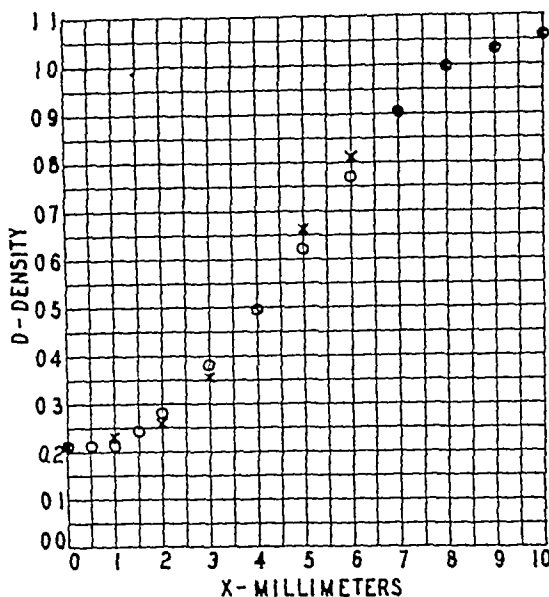


Fig. 7. Calculated (o) and experimentally determined (x) variations of roentgenographic densities D with v (Fig. 1) for three cases.

Fig. 7-A $\lambda_1 = v_2$ or $\frac{\lambda_2}{v_1} = 1$

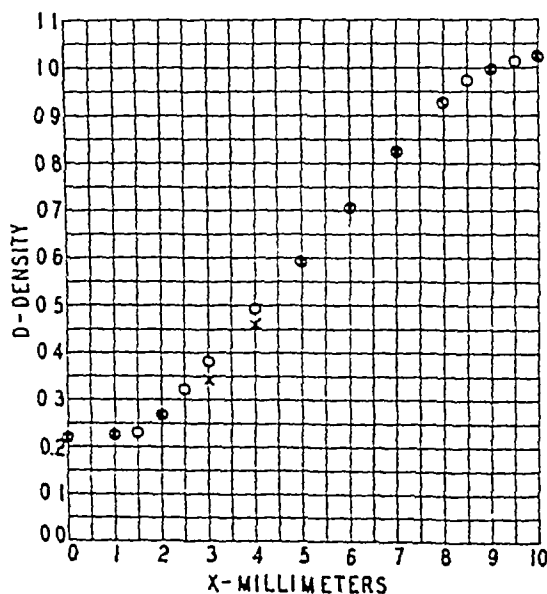


Fig. 7. Calculated (o) and experimentally determined (x) variations of roentgenographic densities D with x (Fig. 1) for three cases.

Fig. 7-B $x_2 = 2x_1$ or $\frac{x_2}{x_1} = 2$

film in the apparatus successively at a distance of 80 centimeters from the roentgen-ray tube with different exposure times.

The film was developed in the same manner as test films. The density of each area was measured by means of the microdensitometer. A curve was constructed of exposure time *vs* roentgenographic density.

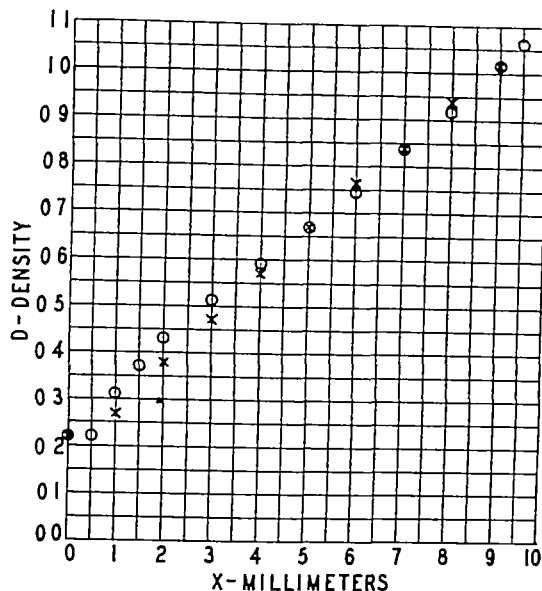


Fig. 7. Calculated (o) and experimentally determined (x) variations of roentgenographic densities *D* with *x* (Fig. 1) for three cases.

Fig. 7-C $\nu = 0$ or $\frac{\nu_2}{x_1} = 0$

This curve is shown in Figure 6. Although the exposure time was varied in the tests used to obtain this characteristic curve the abscissas may be unambiguously called exposure units. Since all of the work herein described is concerned with this particular sample of γ -ray film, it is unnecessary to attempt to find the exposure in absolute units.

The following calculation describes the method used for obtaining theoretically the variation of roentgenographic density with ν , the distance along the unsharp shadow border. This calculation is given completely below for roentgenogram No. 2, for which the data are given in Table I. It is first necessary to measure the maximum density and the minimum density of roentgenogram No. 2. These are, respectively, 1.02 and 0.22. From the curve in Figure 6 it may be seen that in arbitrary

$$\frac{E_{\max}}{\text{or } I} = 3.00 = IT$$

$$\frac{E_{\min}}{\text{or } I_0} = 0.176 = I_0 T$$

since $T = 3$ seconds

The exposure data for roentgenogram No. 2 are

$$\begin{aligned} a &= 50 \text{ cm} \\ b &= 30 \text{ cm} \\ v &= 0.125 \text{ cm/sec} \\ \lambda_1 &= \frac{bf}{a} = 0.3 \text{ cm} \\ \nu &= \frac{a+b}{a} vT = 0.6 \text{ cm} \\ \nu_2 - \nu_1 &= \lambda_1 = 0.3 \text{ cm} \\ T &= 3 \text{ seconds} \\ f &= 0.5 \text{ cm} \end{aligned}$$

The formula for the total exposure E_a from $\nu = 0$ to $\nu = \frac{bf}{a}$ has been obtained from Section I

$$E_a = \frac{1}{2} \frac{a^2(I - I_0)}{bfv(a+b)} \alpha^2 + I_0 T$$

Substituting the values of I and I_0 obtained above, this formula for E_a reduces to

$$E_a = 7.84 \alpha^2 + 0.176$$

The values of E_a are calculated for $\alpha = 0, 0.05, 0.10, 0.30$ cm. For each value of E_a so calculated the density D_a is read from the curve, Figure 6. In Table II the values of α , E_a , and D_a are listed.

TABLE II

α cm	E_a Arbitrary Units	D_a
0	0.176	0.22
0.05	0.196	0.23
0.10	0.254	0.28
0.15	0.352	0.32
0.20	0.490	0.38
0.25	0.686	0.43
0.30	0.882	0.48

A similar procedure is used to calculate densities for points between ν_1 and ν_2 by means of the equation for E_β which is

$$E_\beta = \frac{a}{v(a+b)} (I - I_0) \beta + \frac{bf}{2v(a+b)} (I - I_0) + I_0 T$$

$$(0 \leq \beta \leq (x_2 - x_1))$$

and for points between ν_2 and ν_3 by means of the equation for E_δ which is

$$E_\delta = -\frac{a^2}{2bfv(a+b)} (I - I_0) \delta^2 + \frac{a}{v(a+b)} (I - I_0) \delta$$

$$- \frac{bf}{2v(a+b)} (I - I_0) + IT \quad (0 \leq \delta \leq (x_3 - x_2))$$

Values of I and I_0 , obtained above, are substituted in the formulas for E_β and E_d . From these calculated exposures the densities are read from Figure 6

Data calculated in this manner for test

values of v_1 and v_2 but with the further qualification that $(v_1 + v_2)$ is constant for all three films. It is clear that the unsharpness which would be observed if these three films were held before an illuminator

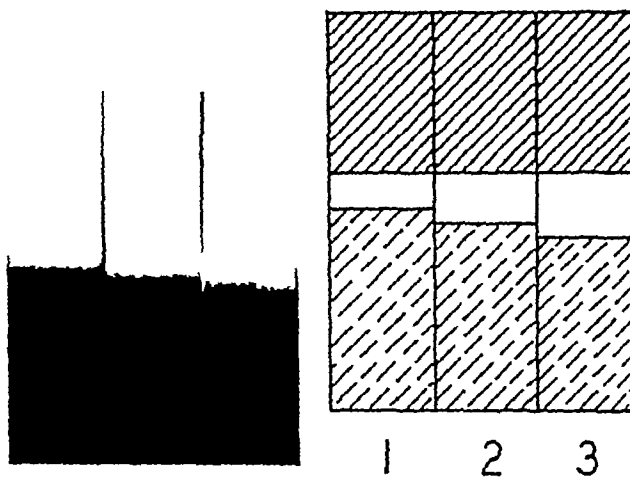


Fig 8 (left) Contact prints of roentgenograms 1, 2, 3, the techniques for which are listed in Table I. Left, roentgenogram

No 1 total unsharpness " 0.86 cm, $\frac{\lambda_2}{v_1} = 1$ approximate observed unsharpness, 0.44 cm Center, roentgenogram No 2 total unsharpness " 0.90 cm, $\frac{\lambda_2}{v_1} = 2$ approximate observed unsharpness 0.67 cm Right roentgenogram No 3 "total unsharpness 0.90 cm, $\frac{\lambda_2}{v_1} = 0$, approximate observed unsharpness 0.90 cm

Fig 8 (right) Line drawing showing widths of shadows measured by observers. Broken line cross hatching represents the areas of the original films of density 0.2, solid line cross-hatching represents the areas having a density of 1.0, the small areas without cross hatching represent areas of observed unsharpness

films 1, 2, and 3 are plotted (o) in Figure 7. Data obtained experimentally by measuring the test films with the microdensitometer are plotted (λ) in the same figure.

It will be noted that the variations between the experimentally determined density values and those obtained by means of the theory outlined in Section I and the characteristics of the film are within the probable limits of experimental error. This close agreement indicates that the calculations in Section I constitute a consistent theory of the facts obtained experimentally. It will be noted that the curves in Figure 1, as well as those in Figure 7, represent results obtained with different

would be different in spite of the fact that $(v_1 + v_2)$, the "total unsharpness," is the same for all films. The next section is devoted to a discussion of the observed differences in these three films.

Figure 8 is a reproduction of positive prints of test films 1, 2, and 3 for which the techniques are described in Table I. The original films were arranged so that the points $v = 0.9$ cm were in line. Contact prints were then made and these prints reproduced in Figure 8. The darker portions of the prints correspond, of course, to less dense portions of the original films.

A number of observers who examined these films were of the opinion that the

horizontal lines shown in the diagram to the right of the reproduction of the prints represented the borders of the observed unsharpness of the original films. Thus, although the "total unsharpness" is the same for all three films, the observed unsharpness in roentgenogram No 1 is approximately one-half of the unsharpness in roentgenogram No 3, while the unsharpness in roentgenogram No 2 is approximately three-fourths of the observed unsharpness of roentgenogram No 3.

This shows that the observed unsharpness does not depend solely upon the "total unsharpness" but may differ for a given value of $(\nu_1 + \nu_2)$, depending upon the ratio of ν_2 to ν_1 .

III THE DEDUCTION OF TENTATIVE CRITERIA FOR MINIMUM OBSERVED UNSHARPNESS IN CHEST ROENTGENOGRAMS

It has been shown above that the observed unsharpness depends not only upon the "total unsharpness" $(\nu_1 + \nu_2)$ but also upon the ratio of ν_2 to ν_1 . Specifically it has been shown that the observed unsharpnesses in three roentgenograms, for each of which $\nu_1 + \nu_2 = 0.9$ cm, are approximately in the proportion 2 : 3 : 4 for ratios of $\frac{\nu_2}{\nu_1}$ equal to 1, 2, 0, respectively.

The precise application of this result to the problems of chest roentgenography requires the accurate solution of a number of problems discussed in the Introduction and in Section IV below. Nevertheless, the results described above may be combined with the data now available for two purposes: (1) To illustrate the methods of calculation for applying the results given above to chest roentgenographic technique, and (2) to obtain by means of such calculations tentative criteria for chest roentgenographic techniques which will produce minimum observed unsharpness.

This Section (III), therefore, comprises sample calculations combining the results of Section I and II with the practical factors of chest roentgenographic technique.

The results given in this Section in the forms of curves and tabulated data are suggested as tentative criteria for chest roentgenography. The confirmation or modification of these results depends upon the solution of problems outlined in the Introduction and discussed further in Section IV below.

Bouwers (1) has shown how the factors defined above as $\nu_1 = \frac{bf}{a}$ and $\nu_2 = \frac{a+b}{a}vT$

may be reduced to a function of the exposure time T , and the sum minimized, thus specifying techniques for minimum "total unsharpness" $(\nu_1 + \nu_2)$. He has pointed out that the improvement of roentgen-ray films and intensifying screens makes necessary the recalculation of these criteria. The focal spot size f depends upon the electric energy required to make the roentgenogram, and this energy, in turn, is decreased by improvements in films and screens.

At the present time high quality chest roentgenograms may be made with roentgen-ray tube voltages not exceeding 78 kv p and milliampere-seconds and total energies depending upon the focal spot-film distance, as follows:

Focal Spot film Distance		Milliampere seconds	Energy at 78 kv p Watt seconds
Meters	Feet		
1.25	4	8.3	470
1.50	5	12.2	670
1.83	6	18.2	1000

It is further assumed that the *actual* focal spot of a 19° stationary anode line focus roentgen-ray tube may be safely loaded up to 250 watts per square millimeter, and that a rotating anode roentgen-ray tube may be safely loaded up to 1,500 watts per square millimeter. These ratings are in accord with modern practice, if the exposure time does not exceed 0.15 second.

Postero-anterior roentgen kymography of the profile of the heart has shown velocities parallel to the film up to one centimeter per second in normal patients under normal conditions and higher velocities in patients whose hearts are abnormal.

or who are excited or who have just exercised violently. It seems probable that during the diastolic phase of the cardiac cycle these velocities are generally less than 0.5 cm per second. Several writers, in order to calculate roentgenographic unsharpness, have assumed an average velocity for the heart, and for the vessels near the heart, of 0.5 cm per second. In the calculations which follow data are given for $v = 0.5$ cm per second and for $v = 0.25$ cm per second, the higher figure is judged to be a mean, subject to wide variations, for roentgenograms made at random cardiac phase, the lower value is assumed to hold for roentgenograms taken in the diastolic phase of the cardiac cycle.

As noted in Section II, the test roentgenograms 1, 2, 3 were made so that the ratios $\frac{v_2}{v_1}$ were 1, 2, 0, respectively. The observed unsharpnesses for these films were judged to be in the ratio 2:3:4, respectively. If this triple ratio is expressed in terms of $(v_2 + v_1)$, which was constant for all three films, it is $1/2, 3/4, 1$. Note also that in chest roentgenography the ratio $\frac{v_2}{v_1}$ lies between limits $0.05 \leq \frac{v_2}{v_1} \leq 2.5$ for all techniques used in practice.

It is concluded, therefore, that the observed unsharpness U_o may be expressed

$$U_o = b \left(\frac{v_2}{v_1} \right) (x_2 + x_1)$$

where $\Phi\left(\frac{v_2}{v_1}\right)$ is a function of $\frac{v_2}{v_1}$, so chosen that the results obtained in Section II are satisfied. The function $\Phi\left(\frac{v_2}{v_1}\right)$ must, therefore, be chosen so that

$$U_o \Big|_{\frac{v_2}{v_1} = 0} = 1 \quad (x_2 + x_1) \quad (\text{test film No. 3})$$

$$U_o \Big|_{\frac{v_2}{v_1} = 1} = \frac{1}{2} \quad (x_2 + x_1) \quad (\text{test film No. 1})$$

$$U_o \Big|_{\frac{v_2}{v_1} = 2} = \frac{3}{4} \quad (x_2 + x_1) \quad (\text{test film No. 2})$$

The function $\Phi\left(\frac{v_2}{v_1}\right)$, for which three values have been obtained, could be expressed accurately as a power series in $\frac{v_2}{v_1}$.

However, aside from the complication of calculations with such a function, there is no need for such accuracy as long as the velocities of roentgenographed parts are known only approximately. In view of these facts the function $\Phi\left(\frac{v_2}{v_1}\right)$ is defined as follows

$$\Phi\left(\frac{x}{x_1}\right) \equiv 1 - \frac{1}{2} \frac{x_2}{x_1} \quad 0 \leq \frac{x_2}{x_1} \leq 1$$

$$\Phi\left(\frac{x}{x_1}\right) \equiv \frac{1}{4} \left(1 + \frac{x}{x_1} \right) \quad 1 \leq \frac{x_2}{x_1} \leq 3$$

Note that this definition is based upon the values of observed unsharpness for test films Nos. 1, 2, and 3, so that $\Phi(1) = \frac{1}{2}$,

$$\Phi(2) = \frac{3}{4}, \quad \Phi(0) = 1$$

The observed unsharpness U_o is, therefore

$$U_o = \left(1 - \frac{1}{2} \frac{x_2}{x_1} \right) (x_2 + x_1) \quad 0 \leq \frac{x_2}{x_1} \leq 1$$

$$U_o = \frac{1}{4} \left(1 + \frac{x_2}{x_1} \right) (x_2 + x_1) \quad 1 \leq \frac{x_2}{x_1} \leq 3$$

It is, therefore, possible to calculate the observed unsharpness in a roentgenogram of an object b cm from an x-ray film which is $a + b$ cm from a tube having an effective focal spot f cm square if this object moves parallel to the film with a constant velocity v cm per second throughout an x-ray exposure of constant intensity of duration T seconds. Examples of such calculations follow. As noted in the beginning of this Section and discussed in Section IV, the results of these calculations may be tentatively applied to chest roentgenographic technique, subject to modification when the factors of this technique may be determined more precisely.

The calculations which follow lead to the graphical representation of the observed unsharpness, as a function of exposure time, of the border of an object moving parallel

horizontal lines shown in the diagram to the right of the reproduction of the prints represented the borders of the observed unsharpness of the original films. Thus, although the "total unsharpness" is the same for all three films, the observed unsharpness in roentgenogram No 1 is approximately one-half of the unsharpness in roentgenogram No 3, while the unsharpness in roentgenogram No 2 is approximately three-fourths of the observed unsharpness of roentgenogram No 3.

This shows that the observed unsharpness does not depend solely upon the "total unsharpness" but may differ for a given value of $(\nu_1 + \nu_2)$, depending upon the ratio of ν_2 to ν_1 .

III THE DEDUCTION OF TENTATIVE CRITERIA FOR MINIMUM OBSERVED UNSHARPNESS IN CHEST ROENTGENOGRAMS

It has been shown above that the observed unsharpness depends not only upon the "total unsharpness" $(\nu_1 + \nu_2)$ but also upon the ratio of ν_2 to ν_1 . Specifically it has been shown that the observed unsharpnesses in three roentgenograms, for each of which $\nu_1 + \nu_2 = 0.9$ cm., are approximately in the proportion 2 3 4 for ratios of $\frac{\nu_2}{\nu_1}$ equal to 1, 2, 0, respectively.

The precise application of this result to the problems of chest roentgenography requires the accurate solution of a number of problems discussed in the Introduction and in Section IV below. Nevertheless, the results described above may be combined with the data now available for two purposes: (1) To illustrate the methods of calculation for applying the results given above to chest roentgenographic technic, and (2) to obtain by means of such calculations tentative criteria for chest roentgenographic technics which will produce minimum observed unsharpness.

This Section (III), therefore, comprises sample calculations combining the results of Section I and II with the practical factors of chest roentgenographic technic.

The results given in this Section in the forms of curves and tabulated data are suggested as tentative criteria for chest roentgenography. The confirmation or modification of these results depends upon the solution of problems outlined in the Introduction and discussed further in Section IV below.

Bouwers (1) has shown how the factors defined above as $\nu_1 = \frac{bf}{a}$ and $\nu_2 = \frac{a+b}{a}vT$

may be reduced to a function of the exposure time T , and the sum minimized, thus specifying technics for minimum "total unsharpness" $(\nu_1 + \nu_2)$. He has pointed out that the improvement of roentgen-ray films and intensifying screens makes necessary the recalculation of these criteria. The focal spot size f depends upon the electric energy required to make the roentgenogram, and this energy, in turn, is decreased by improvements in films and screens.

At the present time high quality chest roentgenograms may be made with roentgen-ray tube voltages not exceeding 78 kv p and milliampere-seconds and total energies depending upon the focal spot-film distance, as follows:

Focal Spot-film Distance		Milliampere seconds	Energy at 78 kv p Watt seconds
Meters	Feet		
1.25	4	8.3	470
1.50	5	12.2	670
1.83	6	18.2	1000

It is further assumed that the *actual* focal spot of a 19° stationary anode line focus roentgen-ray tube may be safely loaded up to 250 watts per square millimeter, and that a rotating anode roentgen-ray tube may be safely loaded up to 1,500 watts per square millimeter. These ratings are in accord with modern practice, if the exposure time does not exceed 0.15 second.

Postero-anterior roentgen kymography of the profile of the heart has shown velocities parallel to the film up to one centimeter per second in normal patients under normal conditions and higher velocities in patients whose hearts are abnormal.

and if it is desired to use one x-ray tube for all adult chests, technics may be calculated for minimum observed unsharpness at focal spot-film distances from 1.25 meters (4 feet) to 1.83 meters (6 feet). These technics are listed in Table III.

anode tube having an effective focal spot 1.4 mm square *with the other technical factors unchanged*, experience suggests that the shadow borders in the second film are sharper than those in the first. It is quite true that the shadows of the posterior ribs

TABLE III—TECHNICS FOR MINIMUM OBSERVED UNSHARPNESS FOR OBJECT 15 CM FROM THE ROENTGEN-RAY FILM MOVING WITH CONSTANT VELOCITY v IN A DIRECTION PARALLEL TO THE FILM

		Focal Spot-film Distance		
		1.25 m 4 feet	1.5 m 5 feet	1.83 m 6 feet
$v = 0.5 \text{ cm/second}$	Stationary anode tube (observed unsharpness 0.41 mm)	Effective focal spot side (mm)	3.0	3.6
		Roentgen ray tube voltage (kv p)	50-78	50-78
		Roentgen-ray tube current (ma)	120	174
		Exposure time (seconds)	0.07	0.07
		Effective focal spot side (mm)	1.6	1.9
	Rotating anode tube (observed unsharpness 0.23 mm)	Roentgen ray tube voltage (kv p)	50-78	50-78
		Roentgen ray tube current (ma)	208	305
		Exposure time (seconds)	0.04	0.04
		Effective focal spot side (mm)	2.4	2.8
		Roentgen-ray tube voltage (kv p)	50-78	50-78
$v = 0.25 \text{ cm/second}$	Stationary anode tube (observed unsharpness 0.34 mm)	Roentgen ray tube current (ma)	76	111
		Exposure time (seconds)	0.11	0.11
		Effective focal spot side (mm)	1.3	1.6
		Roentgen-ray tube voltage (kv p)	50-78	50-78
		Roentgen ray tube current (ma)	139	203
	Rotating anode tube (observed unsharpness 0.19 mm)	Exposure time (seconds)	0.06	0.06
		Effective focal spot side (mm)	1.3	1.6
		Roentgen-ray tube voltage (kv p)	50-78	50-78
		Roentgen ray tube current (ma)	139	203
		Exposure time (seconds)	0.06	0.06

IV OTHER FACTORS WHICH INFLUENCE THE OBSERVED UNSHARPNESS IN CHEST ROENTGENOGRAMS

It is the purpose of this Section to derive certain conclusions from the work described above and to point out certain factors in chest roentgenographic technic which are not included in the analysis in those Sections.

Figure 9 shows that equal observed unsharpnesses (0.43 mm) are produced with an exposure time of 0.067 second for a stationary anode tube and for a rotating anode tube. The sides of the effective focal spots are 3.6 mm for the stationary anode tube and 1.4 mm for the rotating anode tube. This result may appear anomalous since if a chest roentgenogram is made with a stationary anode tube having an effective focal spot 3.6 mm square, and a second film is made with a rotating

and of the parts of the lung which move slowly during exposure will be more sharp in the second film. However, the profile of the heart and the shadows of vessels near the heart will have the same unsharpness in both films, if they move parallel to the film with a velocity of 0.5 cm per second as it was assumed when the data for the Curves 1 and 2, Figure 9, were calculated. This point is discussed further below.

Note that the slopes of Curves 1 and 2, Figure 9, change more rapidly near the points of minimum unsharpness than the slopes of Curves 3 and 4 at corresponding points. This leads to the conclusion that, if it is necessary or desirable to deviate from the exposure times of minimum unsharpness, there is a smaller loss of sharpness for objects moving slowly than for those moving faster. Therefore if a large part of the object roentgenographed moves

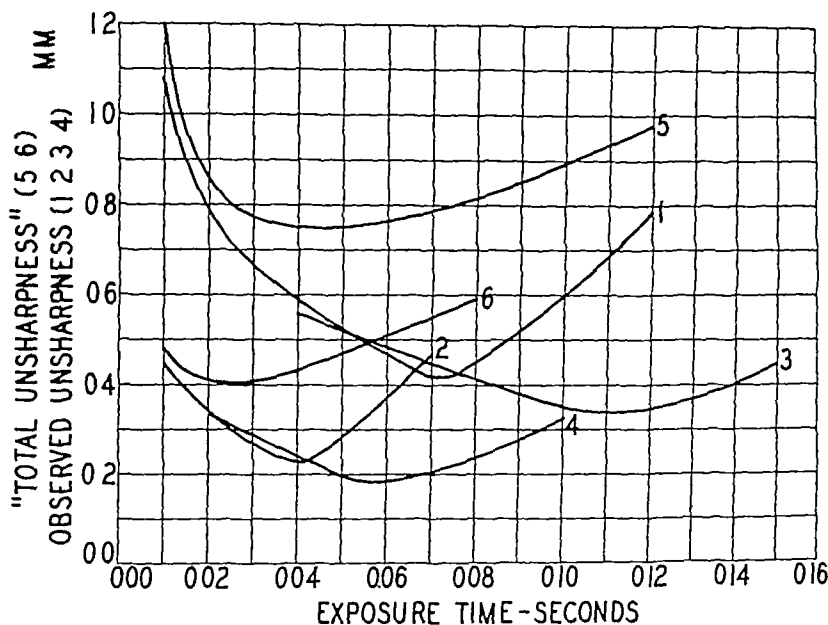


Fig 9 Calculated relations between "total" and observed unsharpness, and exposure time

Curve No	Unsharpness	Velocity of Object (v) cm per sec	Type of Roentgen-ray Tube
1	Observed (U_0)	0.5	stationary anode
2	Observed (U_0)	0.5	rotating anode
3	Observed (U_0)	0.25	stationary anode
4	Observed (U_0)	0.25	rotating anode
5	Total ($x_1 + x_2$)	0.5	stationary anode
6	Total ($x_1 + x_2$)	0.5	rotating anode

to the x-ray film with a velocity 0.5 cm per second neglecting the unsharpness due to films and intensifying screens. The focal spot-film distance is 1.5 meters (approximately 5 feet), the required exposure is 670 watt seconds,³ the object is 15 cm from the film and the x-ray tube is of the 19° line focus type. The required data are

$$\begin{aligned} a &= 135 \text{ cm} & \text{Actual focal spot area—} 3f^2 \text{ cm}^2 \\ b &= 15 \text{ cm} & \text{Energy for exposure—670 watt seconds} \\ v &= 0.5 \text{ cm/sec} & \text{Load capacity of tube—250 watts/mm}^2 \text{ or } 25,000 \text{ watts/cm}^2 \end{aligned}$$

$$x_2 = \frac{a+b}{a} vT = 0.556T \text{ cm}$$

$$3f^2 = \frac{670}{25,000T} \quad f = 0.0945T^{-1/2} \text{ cm}$$

$$v_1 = \frac{bf}{a} = 0.0105T^{-1/2} \text{ cm}$$

$$\frac{v_2}{x_1} = 53T^{3/2}, \quad \frac{v_2}{x_1} = 1 \text{ if } T = 0.071 \text{ sec}$$

Substituting these values in the equations given in the last paragraph

$$\begin{aligned} U_0 &= 0.28T + 0.0105T^{-1/2} - 14.87T^{3/2} \\ &\quad (0.01 \leq T \leq 0.07) \\ U_0 &= 0.28T + 0.0026T^{-1/2} + 7.47T^{3/2} \\ &\quad (0.07 \leq T \leq 0.12) \end{aligned}$$

The results are shown in Curve 1, Figure 9. In a similar manner Curves 2, 3, 4, Figure 9, were calculated for $v = 0.5 \text{ cm/sec}$ with a rotating anode tube, $v = 0.25 \text{ cm/sec}$ with a stationary anode tube, and $v = 0.25 \text{ cm/sec}$ with a rotating anode tube, respectively. Curves 5 and 6 show the "total unsharpness" ($x_2 + x_1$) as a function of exposure time T .

Note that, as might be expected from the nature of the problems, each curve of Figure 9 specifies the unsharpness at any focal spot-film distance from 1.25 meter to 1.83 meters. Although there are different formulas for f for each focal spot-film distance, the values of v_1 and v_2 as functions of T are approximately the same for all distances within this range.

If the factors assumed for these calculations are correct for chest roentgenography,

³ See page 460

It might be concluded from the material above that exposure times greater than those given in Table III and focal spots smaller than those listed in this Table would produce films most useful in view of present knowledge. However, until this knowledge is extended the optimum technics cannot be precisely determined. For example, there may be cases in which the sharp delineation of shadows near the base of the heart is of extreme importance. In this particular case a knowledge of the velocities of the parts in this region, and a device for making exposures in a predetermined cardiac phase would make possible the minimization of unsharpness *in this region*. Throughout the remainder of the chest shadow the unsharpness would probably be excessive, so that a second film, taken at a different technic might be required.

SUMMARY

1 Theoretical derivations and experimental results show that the observed unsharpness of an object moving with constant velocity parallel to a roentgen-ray film (without intensifying screens) differs, in general, from the arithmetic sum of the unsharpness due to object motion and the unsharpness due to the finite focal spot size.

2 Methods are described for calculating the observed unsharpness of the roentgenographic shadow of an object moving with constant velocity parallel to the film as a function of exposure time.

3 The observed unsharpness is calculated for a plane object distant 15 cm from the roentgen-ray film with velocities of 0.5 cm per second and 0.25 cm per second, using both stationary anode tube and rotating anode tube of modern design.

4 These calculations show that for focal spot-film distances between 1.25 meter and 1.83 meters (4 feet to 6 feet), the unsharpness of the shadow border of the object is minimum for exposure times as follows:

Tube	Object Velocity (cm per sec)	Exposure Time for Minimum Unsharpness (second)	Observed Unsharpness (Without Intensifying Screens) (mm)
Stationary anode	0.5	0.07	0.41
Rotating anode	0.5	0.04	0.23
Stationary anode	0.25	0.11	0.34
Rotating anode	0.25	0.06	0.19

for the exposure energies required for chest roentgenography.

5 The unknown factors which prevent the precise calculation of the criteria for minimum observed unsharpness in chest roentgenograms are discussed. Methods for studying some of those factors are outlined.

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relatively slowly, the exposure time may be increased and the focal spot size decreased *without obtaining gross unsharpness in the faster moving parts if these parts move with velocities of 0.25 cm per second or less*. If, as suggested below, most of the parts within the thorax move relatively little, then the greatest overall or "average" sharpness will be attained by making all exposures in the diastolic phase of the cardiac cycle, *i e*, during the interval when the parts having the highest velocities are moving most slowly.

The general conclusions concerning the relation of observed unsharpness to "total unsharpness" were further tested by the following experiment. Note that in roentgenogram No. 1, (Table I) $v_1 = 0.43$ cm, $v_2 = 0.425$ cm, $U_o = 0.43$ cm. According to the conclusions reached in Section III, if an exposure were made at exactly the same technic but with the object stationary, there would result $v_1 = 0.43$ cm, $v_2 = 0$ cm, $U_o = 0.43$ cm. Two films were made in this manner and are reproduced in Figure 10. Although they differ in ap-

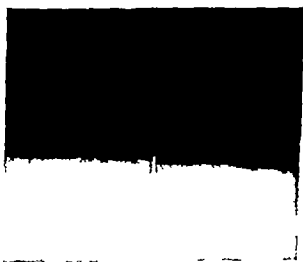


Fig. 10 Left $v_1 = 0.43$ cm, $v_2 = 0$ cm, $U_o = 0.43$ cm

Fig. 10 Right $v_1 = 0.43$ cm, $v_2 = 0.425$ cm, $U_o = 0.43$ cm

pearance (*i e*, density is a different function of v in the two cases), a number of observers held that the widths of the shadow borders were equal.

Two further questions arise concerning the applicability of these results to chest roentgenography.

1 Is the function $\Phi\left(\frac{v_2}{v_1}\right)$ dependent

upon the magnitude of the "total unsharpness"?

2 Does the function $\Phi\left(\frac{v_2}{v_1}\right)$ depend upon the contrast between the two areas of the film between which the unsharpness is produced?

The function $\Phi\left(\frac{v_2}{v_1}\right)$ was chosen upon the basis of roentgenograms having a contrast of 0.8 and for which $v_1 + v_2 = 0.9$ cm. The experiments were repeated with contrasts² of 0.1 and 0.2, and also with a "total unsharpness" of 0.2 cm. In all cases observers concluded that the results described above were valid. However, if the data required for a precise study of chest roentgenography are obtained, these tests should be repeated with a view to extending the results to "total unsharpnesses" less than 0.1 cm. Such tests require a refinement of the experimental method described above, but no fundamental modification thereof.

As noted in the Introduction, the unsharpnesses due to intensifying screens and to x-ray film require further study. Plans for such studies have been formulated. It is hoped, incidentally, that an objective measure of intensifying screen unsharpness may be obtained as a by-product of this work.

Before more definite criteria for minimum unsharpness in chest roentgenograms may be obtained it is necessary to study in more detail the motion of parts within the thorax. This may be done with the aid of a kymograph and a device for making roentgenographic exposures at any predetermined phase of the cardiac cycle.

If these physical measurements are made, it will be possible to record shadows of parts within the thorax in such a manner that the unsharpnesses may be accurately calculated. Under these conditions the roentgenologist could study films made in a variety of ways to determine just what shadows must be sharp if the diagnostic value of the film is to be as high as possible.

² The average film densities were 1.00.

there is enlargement. An associated thymus hyperplasia will vary the cardiac size and form.

CASE REPORTS

Case 1 B A, 14-year-old boy, was referred by Dr D Raff on Nov 8, 1934. He appeared well developed and in good health. The cardiac size and sounds were normal, no murmur being present. The cardiac impulse was felt in the right sixth intercostal space. The electrocardiogram was characteristic of dextrocardia. The teleroentgenogram (Figs 1-A and 1-B) showed dextrocardia. The measurements were: Right margin, 9 cm, left margin, 4 cm, longitudinal diameter, 14.5 cm, chest transverse, 28 cm. The right diaphragmatic dome was slightly lower than the left, and below it the gastric air bubble and the gas-filled splenic flexure were visualized. The barium meal confirmed the complete situs inversus viscerum.

Case 2 Baby V B, female, was born Jan 4, 1933, a spontaneously delivered, full-term child. At birth, the left nipple was seen to be absent, and there was indrawing of the left anterior chest wall on deep inspiration.



Fig 2 A

Roentgen examination on January 6 (Fig 2-4) showed an aplasia of the anterior osseous portions of the left first, second,



Fig 1 A



Fig 1 B

THE CONGENITAL HEART¹

A RADIOLOGIC STUDY, WITH SEVEN REPORTED CASES

By J. FRIEDMAN, M.D., *New York City*

SEVEN cases of congenital heart disease (five newborn infants and two children of eight and one-half and fourteen years, respectively), clinically and roentgenologically observed, are reported, with three necropsies. This group comprises

- 4 cases of Fallot's tetralogy, one of them with right-sided aortic arch and one with complete transposition of the great vessels,
- 1 case of Eisenmenger's tetralogy, with coarctation,
- 1 case of complete dextrocardia,
- 1 case of partial dextrocardia

proved many apparently quite certain clinical and roentgenologic diagnoses. Some of these anomalies show pathognomonic roentgenologic signs, as coarctation of the aorta and right-sided aortic arch, others have a normal roentgen appearance, while in still others, the roentgenologic signs are capable of various interpretations. An example of the latter is the dilated pulmonary arch, held by Vaquez to be typical of a persistent ductus Botalli and by Assmann as significant of pure pulmonary stenosis. These anomalies are nearly always multiple, complicating still more the diagnostic difficulties.



Fig 1-A



Fig 1-B

Congenital heart disease is rare and its diagnosis difficult. Autopsies have dis-

¹ From the Roentgen Department of the Women's General Hospital, Montreal. The writer wishes to thank Dr. W. H. Chase and Dr. H. Segall for their valuable contributions.

In the newborn the heart is globular, its left half rounded off, the left border showing only two arches, namely, the aorta and the ventricle. As to its size, it is often extremely difficult to decide whether or not



Fig 5-1



Fig 5 B

Case 4 Baby R, female, born Jan 7, 1932, a full-term infant delivered by cesarean section. Cyanosis became definite shortly after birth and was controlled only by continuous administration of oxygen. A rough systolic murmur was heard all over the precordium, being loudest in the aortic area. An electrocardiographic report on January 10 was as follows: "Normal axis, low voltage in all leads, and inverted T waves point to toxic myocardial condition, in this case probably due to anorexia." Roentgen examination on January 10 showed a large globular heart and a widened supracardiac shadow. Clinically and roentgenologically the case was considered a thymus hyperplasia rather than a congenital heart. Radium was applied. The baby died on the fourth day of life. The autopsy findings were as follows: transverse precordium, 7 cm (right margin, 3 cm, left margin, 4 cm). There was a rather large thymus, extending to 2 cm above the base of the precordial spine, 3 cm wide at the base of the pericardium, but not extending beyond its lateral border. The weight of the thymus gland was 20 grams. The very large right ventricle lay transversely. There was marked hypertrophy and dilatation of

both right and left ventricles. The large aorta rose entirely from the right ventricle. There was partial atresia of the pulmonary orifice, with a very narrow conus; the first part of the pulmonary artery showed marked dilation. A small defect existed at the base of the intraventricular septum under the pulmonary valve. Both the ductus arteriosus and the foramen ovale were widely patent. The conclusion was that the case was one of the tetralogy of Fallot, with transposition of the great vessels.

Case 5 Baby R, female, was born March 17, 1933, by spontaneous delivery. Hematuria was noticed for the first week after birth, and on March 24 there was cough, followed by choking spells and cyanosis. Similar paroxysmal cyanotic attacks recurred in the next few months. The physical signs were negative, no murmur being heard. Roentgen-ray examination on April 8 showed a large globular heart and enlarged thymus with tracheal displacement and compression. Radium was twice applied, without result. The electrocardiographic report, on June 3, was as follows: "Marked right axis deviation signifying right ventricular preponderance. This points to pulmonic obstruction which is most likely complete (atresia)



Fig 3

third, fourth, and fifth ribs. A dextrocardia without transposition of the viscera was found. The heart was globular, the sounds normal, there was no murmur. The electrocardiographic report, January 20, was as follows: "The degree of right axis deviation is within normal limits for an infant of this age, in whom the right ventricle

is larger than the left under normal conditions."

The child was seen two years later, in perfect health. Roentgen examination (Figs 2-B and 2-C), made on Nov 6, 1934, showed dextrocardia and, more clearly, the costal defects.

Case 3 Baby H, male, born Nov 20, 1932, of a healthy mother, by spontaneous, normal delivery. He seemed perfectly well until the fifteenth day of life, when he developed a series of attacks of cyanosis and died two days later. The x-ray examination on December 5 (Fig 3) showed a globular heart enlarged to the right and left. The necropsy findings were transverse precordium, 7 cm, thymus (rather small), 9 gm, large defect in the intraventricular septum, hypertrophic dilatation of the right and left ventricles, dextroposition of the aorta, the valve over-riding the septal defect. There was coarctation of the aorta near the isthmus. The pulmonary artery was dilated, thin-walled, and well preserved. Patent foramen ovale and a large patent ductus arteriosus. The conclusion was that this was a case of the tetralogy of Eisenmenger, with coarctation.



Fig 4-A



Fig 4-B



Fig 7-A



Fig 7-B

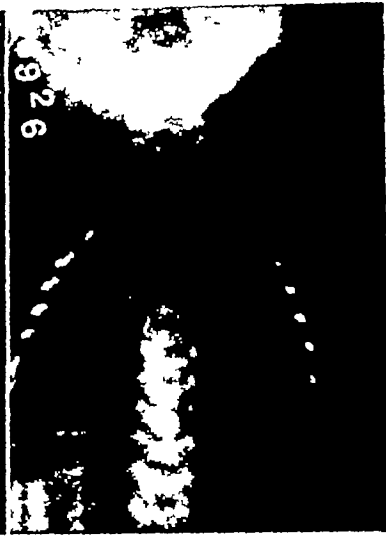


Fig 7-C

X-ray films were taken at six months and at eight and one-half years. Figure 6-B is a postero-anterior teleroentgenogram, Figure 6-C the lateral, and Figure 6-D the second oblique view. The heart is seen to be rather small in the vertical position. The right auricle is markedly prominent. The ascending aorta ascends 1 cm to the right of the spine, while the aortic knob is visualized to the left of the spine. The pulmonary artery is retracted and the left hilum shows up clearly. The left ventricular arch is of increased convexity, the apex rounded off and slightly raised. The measurements are: right margin, 3 cm, left margin, 4 cm, longitudinal diameter, 8 cm, chest transverse, 19 cm. The hila are moderately widened, increased linear markings extending toward the over-aerated lung bases. The diaphragmatic domes are straightened and much depressed during inspiration. The impression from the history, the clinical and roentgenologic findings, and the electrocardiogram is that the case is one of the tetralogy of Fallot.

CASE 7. Baby M, male, born June 6, 1933, spontaneously at full term. The infant was cyanotic from birth; no murmur was heard and the sounds were normal. X-ray examinations were made July 10 and December 13. He fed well but continued

to be blue. On December 16 the erythrocyte count was 10,000,000 per cubic millimeter. The cyanosis and respiratory embarrassment increased until death on December 17, at the age of five and a half months.

Figure 7-A shows marked enlargement of the heart shadow transversely with a rounded-off apex pushed to the left and upwards. The right auricle is very prominent. The pulmonary arch is markedly retracted, outlined medially with a sharp concave line, a clear space through which the left main bronchus shows up clearly. The ascending aorta is widened and the aortic arch seems to ride over the right bronchus. No aortic knob is visualized to the left of the spine.

Necropsy Findings—Pecordium, 5 cm, right margin, 3 cm, left margin, 2 cm. The thymus is small (8 mg). The heart lies transversely, with markedly dilated right auricle and ventricle against the diaphragm; the apex is formed by the right ventricle, which is markedly hypertrophied. There is marked stenosis of the pulmonary artery, with an incompletely formed valve and much dilated conus. There is a large defect in the intraventricular septum at its base. The markedly dilated ascending aorta is deviated to the right, the aortic valves over-riding the septal defects. The



Fig 6-1

trocardiographic report was that the case was one of the tetralogy of Fallot.

Case 6 F A , a boy eight and one half years of age, was referred on Nov 7, 1934, by Dr W Burnett. The patient was born at full term, with forceps delivery. The first cyanotic attack was noticed at seven months, after which similar attacks recurred frequently during the ensuing years. At the time of examination cyanosis and clubbed fingers were very marked. Hemoglobin was 152 per cent, erythrocytes per cubic millimeter, 10,000,000. A loud, rough systolic murmur accompanied the second half of the first sound and ran up to the second sound, a murmur that was heard all over the precordium except at the apex. Its maximum was at the pulmonic area, with a faint systolic thrill. The second sound was loud and sharp, loudest at the pulmonic area, and about equally loud in the aortic area. The first sound was reduplicated at the apex. The electrocardiogram showed a marked right axis deviation, typical of right ventricular preponderance as found in Fallot's tetralogy. The high voltage of P wave in lead II suggests enlargement of an auricle—in this case the right

since no murmur of stenosis exists." On September 7 a late, short, rough systolic murmur was heard at the apex. The child died at the age of seven months. The impression gained from the history, clinical and roentgenologic findings, and the elec-



Fig 6 B

Fig 6 C

THE DETERMINATION OF THE NASO-FRONTAL SUTURE AND THE NASION IN THE LIVING

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IN the anthropometry of the living head perhaps the most important point is that at which the sagittal plane crosses the naso-frontal suture, a point known to anthropometrists as the *nasion*. The determination of this point in the living has always been a matter of considerable difficulty, and indeed, it is doubtful whether in the experience of the most competent investigator it has ever been accurately determined in more than a small percentage of cases. The methods which have been customarily used to determine the nasion in the living leave something to be desired,¹ and with the purpose of finding some fairly reliable method of securing this point, the writer undertook an investigation which led to the successful solution of the problem. The preliminary findings of this investigation, based upon the dissection of 240 human dissecting-room cadavera and the small number of ten x-ray studies of the living human head, were published in "The American Journal of Physical Anthropology" for April-June, 1935.² In the present communication the report upon two additional series of experiments is put before the readers of RADIOLOGY, together with the hitherto unpublished x-ray material in the hope that it may be of some use to them in their work.

In my original paper I told how, as a consequence of preliminary dissections on 140 dissecting-room bodies in search of some possible relationship between the soft structures of the head in the orbito-nasal region and the naso-frontal suture, with particular reference to the nasion, I

was led to the conclusion that a very close relationship existed between the level of the superiormost points of the superior palpebral sulci when the upper eyelids were ele-

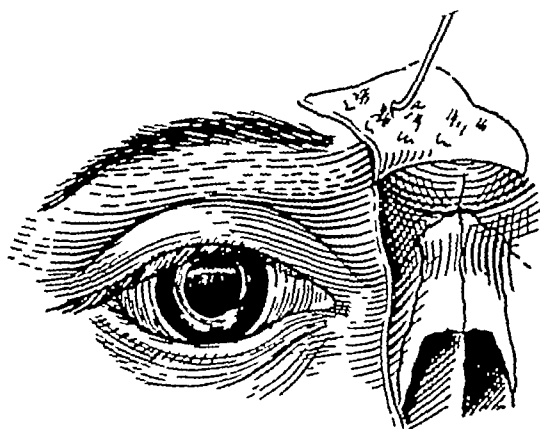


Fig 1 Showing the relationship of the nasion to the level of the superior palpebral sulcus in a white adult male

vated, as when the individual is looking straight ahead, and the level of the nasion (Fig 1). In order to test the constancy, if any, of this suggested relationship the following experimental procedure was adopted. The recumbent head was placed in the Frankfurt Plane (a plane determined by the two inferiormost points on the inferior orbital margins and the auricular points immediately above the external acoustic rings), and by means of a metal tape, a horizontal tangential to the superiormost projection of the arches of the superior palpebral sulci was defined by gently placing the upper border of the tape against these arches. Where this horizontal intersected the mid-sagittal plane, a point determined by the eye alone, a hole was bored vertically through the soft tissues until it was felt that the gunlet used had slightly penetrated the bone. The instrument used in this operation was a 2-

¹For a critical examination of these methods see M F Ashley-Montagu, "The Location of the Nasion in the Living," *Am Jour Phys Anthropol*, 1935, 20, 81-93.

²*Ibid*. This Journal it should here be mentioned contains a great deal of information which radiologists would find extremely valuable.

aortic extends 1 cm to the right of the mid-line, crossing the right bronchus and descending along the right spinal border. Closed ductus arteriosus. There is a large patent foramen ovale, emphysema, and hypospadias.

Conclusion—The case is diagnosed as showing the tetralogy of Fallot with high dextroposition of the aorta.

DISCUSSION

Cases 4 and 7 represent the radiological appearance of Fallot's tetralogy, with the heart in horizontal position, the very dilated right ventricle lying against the diaphragm and occupying nearly the entire cardiac surface. The apex is pushed to the left and raised and formed by the right ventricle. Case 6 represents the small vertical type of heart in Fallot's tetralogy with an hypertrophic right ventricle.

Assmann found the latter type in a case with small intraventricular septum defect and only slightly indicated right-sided aorta. The first type he found in several cases associated with a very large intraventricular septum defect and marked dextroposition of aorta. Our Case 4 showed a small septal defect with transposition of aorta, and Case 7 a large septal defect and right-sided aortic arch.

The degree of pulmonary stenosis, too, will probably influence the size of the right ventricle and so the cardiac form. In both our cases the stenosis of the pulmonary artery was marked. In Case 4 the presence

of the large thymus complicates the interpretation of the cardiac form.

The radiologic appearance of Case 7 with the high dextroposition of the aorta was that of a sharply outlined, concave indentation of the left cardiac border and the *cœur-en-sabot* might be considered to be pathognomonic of Fallot's tetralogy.

The combination of the ventricular septum defect, right-sided aorta, and lack of stenosis of pulmonary artery has been named the Eisenmenger complex. Case 3, as the necropsy brought out, represents this type. The transversely enlarged globular heart should always be considered as suggestive of ventricular septum defect. The absence of right axis deviation in the electrocardiogram led correctly to exclusion of pulmonary stenosis.

Finally, the case of partial dextrocardia was found, as by other observers, to be associated with other deformities (in our case a very unusual rib defect).

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In Figure 3 is seen a typical x-ray view of the head of a white male young adult, in which the apex of the wire may be seen appressed against the skin upon an exact horizontal with the level of the nasion. It will be observed in examining the figure that were a horizontal to be projected posteriorly toward the nasion from the apex of the wire it would strike the nasion precisely. These points are further clarified in the two drawings of another x-ray study seen in Figures 4 and 5. The relationship here demonstrated is precisely that which we endeavor to obtain in our attempts to locate the nasion in the living.

In order to check the accuracy of my procedure on cadavera I requested two of my colleagues to apply the method to some 15 undissected heads, thus they were allowed to do alone and unaided. In every case they were able to strike the nasion exactly. To these gentlemen, Benjamin Freiband and Irving Wechselblatt, I am indebted for their assistance in this experiment.

Since the above observations were made I have had the opportunity to check the accuracy of this method of determining the nasion in two additional series of dissecting-room cadavera. In each series the bodies had been dead and embalmed for some three months, and it was not always easy to reproduce the superior palpebral sulci owing to the considerable loss of tone and shrinkage of the palpebrae. In my earlier series no body had been dead for more than six weeks and it was a matter of no great difficulty to produce the sulci by raising the superior palpebrae.

In the second series examined by myself the method followed was to place a wire tangential to the produced superiormost projection of the superior palpebral sulci while the head was lying on its occiput, and to bore a hole with a sharpened ice-pick at the point at which the sagittal plane intersected this horizontal. No attempt was made to put the head in the Frankfurt Plane, but care was taken to introduce the point of the ice-pick through the tissues at what was estimated to be a

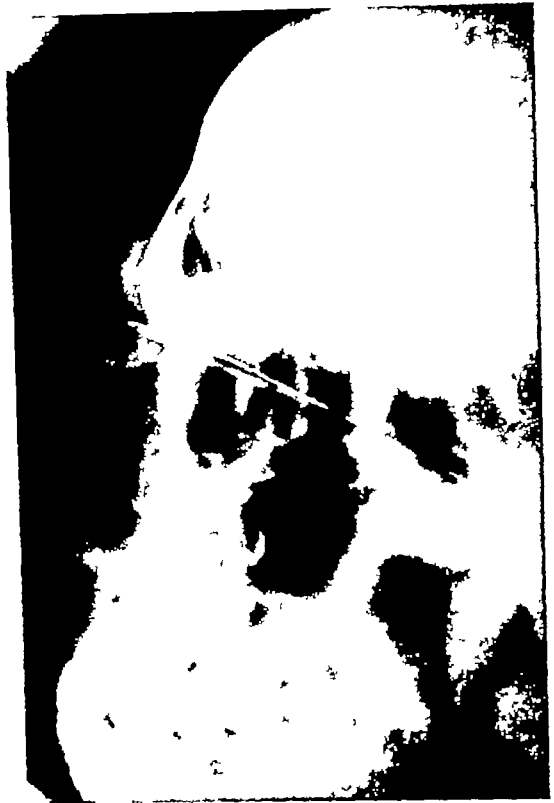


Fig 3 X ray view of the head of a young adult white male showing the apex of the wire appressed against the skin and situated upon an exact level with the nasion the position of the apex of the wire corresponding to the level of the superior palpebral sulci

plane horizontal to the Frankfurt Plane. Out of the 37 cases thus investigated the nasion was determined exactly in 29 cases, and in the remaining eight cases the bore hole was found to be between 1 and 2 mm from the nasion, in one case 2 mm from the nasion on the frontal bone, in three cases 2 mm from the nasion on the nasal bone, and in four cases 1 mm from the nasion on the nasal bone. Allowing for the pooriness of the material and the relative looseness of the method used these results were very gratifying.

It now remained to discover how fool-proof the method was. For this purpose nine enthusiastic graduate students, who were completely untrained in the method here described, were given instructions to determine the position of the nasion by following the method I had used in making my second series of observations. Forty

mm bore hand-gimlet with a sharpened point. A deep incision passing through all the overlying tissues was then made from

sulci and the nasion existed in the living. X-ray studies were made upon the heads of ten adolescent living white males. With

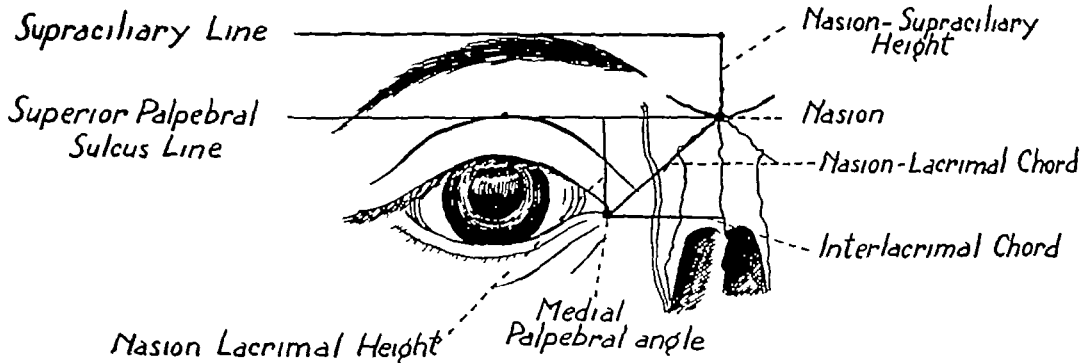


Fig 2 Showing the relationships of the various structures in the naso-orbital region

the glabella to a point midway down the front of the nose, and the whole region exposed, the periosteum was then with great difficulty dissected away from the bone, and the naso-frontal, the internasal suture, and the nasion exposed.

Out of 100 cases thus tested, the nasion was struck in all but three cases, and in these exceptional cases the gimlet hole was found to have penetrated the bone no more than a millimeter or so above the nasion. Such an astonishing series of successes really looked too good to be true, since not even the least informed morphologist would have expected to find so constant a relationship between a part of a structure formed entirely of soft tissues, namely, the most superior projections of the arches of the superior palpebral sulci, and a point formed by the association of purely osseous tissues determined by a plane. But there was no escaping the evidence of the experimental results which proved that the nasion was to be sought for on the same level as the superior points of the superior palpebral sulci when the individual had his eyes open and was looking straight ahead. The point at which the sagittal plane intersected a line extended between these points upon the face practically invariably corresponded to the position of the nasion.

In order to discover whether this relationship between the superior palpebral

one exception only, in which the film was a failure, the nasion, or at least the superior-most projection of the naso-frontal suture in the lateral view, was in each case accurately determined.

The method used in this X-ray study was as follows. The subject, standing upright, was asked to look straight ahead of him with his eyes normally open, so that the superior palpebral sulci were well defined, an ordinary piece of narrow-gauge fuse wire was then applied tangentially to the sulci and tied at the occiput. The subject was then placed horizontally upon his left side and a right lateral nasal exposure was made of the head and face. A lateral view of the region concerned was taken in preference to a frontal view because of the difficulty of interpreting an X-ray view of the naso-frontal suture. In a lateral view it is sometimes possible to see the naso-frontal suture quite clearly defined. When, however, this detail is for some reason obscured, the junction of the frontal and the nasal bones may generally be observed with little difficulty. In six of the ten cases X-rayed the naso-frontal suture was quite clearly visible, in three others the junction of the nasal with the frontal bones was alone visible, and in the tenth case such a junction was quite indistinguishable, the shadow of the frontal merging imperceptibly into that of the nasals.

A DEEP THERAPY TABLE WITH A TUBE STAND COMBINED AND REVOLVING IN ARC
ABOUT THE TABLE INTENSITY DISTRIBUTION WITHIN PARAFFIN PELVIS
FOR VARIOUS PORTALS OF ENTRY

By NATHAN FLAX, M D , Department of Roentgenology, Booth Memorial Hospital,
Covington, Ky

IN the irradiation of neoplasms of the cervix uteri and other mid-line tumors, a technic making use of the smallest of portals of entry, with a tube in constant motion, possesses distinct advantages. A small port, moving-tube technic results in an unusually high depth dose with a low skin surface dose, and a great accuracy in directing the irradiation to the mid-pelvis. While the value of a high depth dose need not be stressed, the value of great precision in the distribution of the dose throughout the pelvis might be dwelt upon.

Proper "angles" at which the radiating beams traverse the pelvis are the basis of the cross-section irradiation charts, with the angles of the radiating beams so arranged as to insure the greatest cross-fire effect in the tumor area. Any deviation from the charted angle must cause an undesirable rearrangement of the intensity distribution within the pelvis, to the detriment of normal tissues and at the expense of tumor effect. Necessarily taken for granted is the ability of the operator to duplicate, by sighting the x-ray tube for an invisible tumor deep in the body, the angle called for in the chart for portals of entry. The small ports required with four-, six- or seven port technics, necessitate the most accurate direction, as an error of only a few degrees in angulation of the tube may result in a complete missing of a small, deep-seated invisible tumor, or if the tumor be too large to be missed altogether, the delivery of only the periphery of the x-ray beam into the tumor and a purposeless if not injurious, irradiation of normal tissues.

On the other hand, a two port technic, consisting of a single large port anteriorly and posteriorly, requires no precise angulation of the tube and the distribution of the irradiation throughout the pelvis conforms to the charted value. Unfortunately,

the depth dose is relatively small. It is felt that with this small-port, moving-tube technic, to be described here, a depth dose is achieved that compares advantageously to any multiple port technic avail-

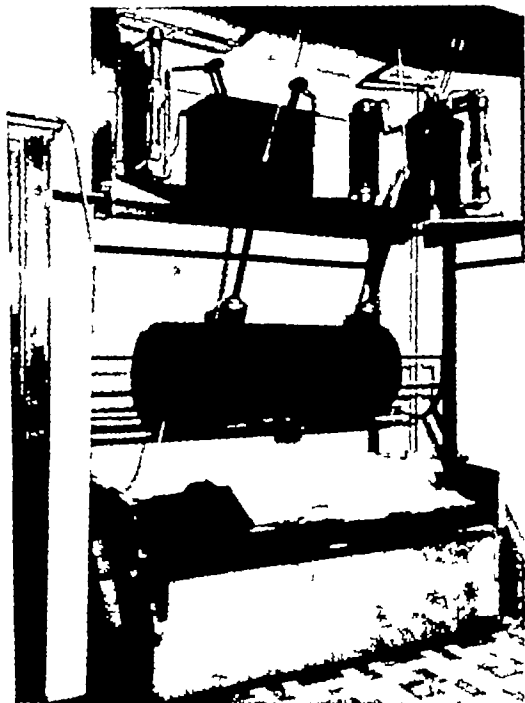


Fig 1

able, and also possesses a precision of distribution of irradiation equal to the conventional two-port technic. This moving-tube technic makes use of a table and tube stand combined which are described as follows:

On a bearing at each end of the table is mounted the tube support for an air-cooled tube which can revolve about the table in an arc, the center of the radius of which arc is fixed and coincides with this bearing. The table top may be raised or lowered independently of the tube support so that the patient may be raised or lowered to bring the tumor area into line with the



Fig 4 Drawing from an x-ray study of another young adult white male. The unbroken line represents the proximal portion of the wire the broken line represents the distal portion of the wire on the other side of the head at the orbit the wire is seen at the superior palpebral sulcus level which conditions the position of the wire at the front of the nose where it is seen upon an exact level with the nasion. It should be quite clear that the position of the wire below the naso-frontal suture is not the position we are concerned with but only with the position of the wire in front of the skin a line between the latter and the nasion has been added to facilitate the reading of the figure



Fig 5 The skull reconstructed from the same negative as that from which Fig 4 was made together with the outline of the soft tissues, showing the result of the experiment perhaps more strikingly than in Figure 4.

Plane and inserted the pick upon a plane horizontal to it through the tissues, the errors, small as they are, would have been appreciably reduced

bodies were available for this purpose. Each student was permitted to carry out the necessary operations without any further instructions or interference from me. The results of this experiment may be read off from Table I, where + means that the nasion was accurately determined, and each figure the amount in millimeters from the nasion of the single observation it represents, the order of the observations being preserved for each student.

From this table it will be seen that the range of the average error of the nine students was from 0.5 to 1.8 mm with an average total error for the 40 observations of 1.1 mm. The errors of the individual observations, however, run from 1 to 5 mm. Allowing for the inexperience of the investigators and the poorness of the material, the results were not at all bad. I feel quite confident if most of the investigators had put the head in the Frankfurt

TABLE I

Student	Observations				Total Error	Av Error
Kr	3	+	3	2	8	1.6
Gr	+	5	+	+	5	1.0
Gi	2	1	+	+	5	1.0
Go	5	1	+	1, +	7	1.4
Su	+	+	2	2	4	1.0
So	2,	2	3	+	7	1.8
Ba	2	+	+	+	2	0.5
Da	+	5	+	+	5	1.2
Ha	2	+	+	1	3	0.7
9	Total	40	Total	46	Total	Av Error 1.1

It thus appears that the method above described for determining the nasion in the living is practically foolproof. It should be obvious, however, that it cannot be used on individuals with overhanging eyefolds or epicanthic folds.

I wish here to express my thanks to Professor Seth Hirsch, of New York University Medical College, for his kind advice and assistance in making the radiographs for this study.

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able, and also possesses a precision of distribution of irradiation equal to the conventional two-port technic. This moving-tube technic makes use of a table and tube stand combined which are described as follows:

On a bearing at each end of the table is mounted the tube support for an air-cooled tube which can revolve about the table in an arc, the center of the radius of which arc is fixed and coincides with this bearing. The table top may be raised or lowered independently of the tube support, so that the patient may be raised or lowered to bring the tumor area into line with the

bearing which represents the center of the radius of the arc through which the tube moves. The tube itself is shifted on its mount, with the long axis of the body to enable its centering over any cross-section level of the body.



Fig 1-A (above)
Fig 1-B (below)

A motor under the table is geared to the bearing supporting the tube mount. Its speed is reduced through the interposition of a gear box, with worm reduction gears, so that the tube mount requires 20 minutes to travel through the half-revolution from one side of the table to the other in an arc about the patient supine or prone upon the table. In this manner, one-half of the patient's body surface is irradiated with one half-circle movement of the tube, and when the patient is turned over and the tube movement is repeated, the entire skin surface is irradiated, with the center of the body as a hub to receive portals of irradiation converging to the center

throughout the entire movement of the tube. In effect, this continuous movement of the tube makes constantly available new skin surfaces as portals of entry. Incidentally, the tube is shockproof, and its slow movement is wellnigh imperceptible to the patient.

At first glance it might appear that this method of irradiation is fraught with danger to the skin, due to the constant overlapping of beams. However, closer scrutiny of the facts reveals that while there is a constant overlapping of beams, it is uniform, accurately controlled and easily measured, differing from that accidental overlapping which may occur in manually directed multiple port techniques and for which accurate allowance cannot be made. Using a chunk of paraffin conforming in external contour to a female pelvis 23 cm deep and 35 cm wide, as established by Arneson and Quimby (*RADIOLOGY*, August, 1935), to be the size of the average female pelvis, the experimental values obtained revealed the spot surface dose to be considerably less than the dose in the center of the pelvis.

The following physical factors were utilized: 200 kv p Villard circuit, 0.5 mm Cu and 1 mm Al added filtration, 5 ma, target-surface distance 58.5 cm to the top of the pelvis and 52.5 cm to the sides of the pelvis (the pelvis not being circular in shape, this variation in target-surface distance is unavoidable). Intensity distribution was charted with the following portals of entry: size in centimeters, 4×15 , 9×15 , 11×15 , and 15×15 , the greatest width of the portal concurring with the long axis of the body of which the pelvis was theoretically a part. It was found that at no time did the spot surface dose exceed the depth dose, with the largest portal 15×15 , an intensity of 100 per cent could be delivered into the center of the pelvis, with 92 per cent as the greatest intensity over any spot on the surface, on the other hand, with the smallest portal, 4×15 , the surface intensity for a depth intensity of 100 per cent was but 50 per cent. Were the surface ex-

posed to its full 100 per cent with a 4×15 cm port, the depth dose would be 200 per cent

around the pelvis in a half-circle, automatically the motor stopped and the x-ray turned off. In this manner readings were

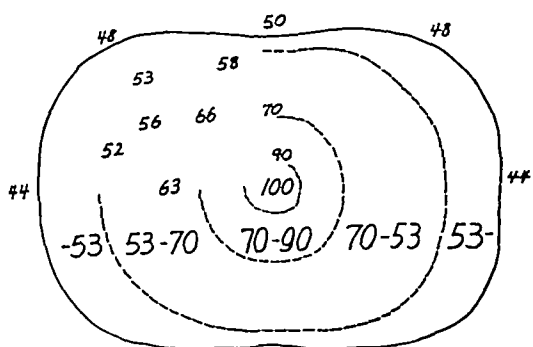


Fig 2

Fig 2 Port 4×15 cm, pelvis 23×35 cm

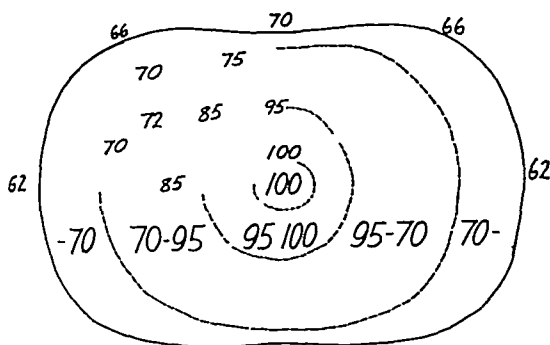


Fig 3

Fig 3 Port 9×15 cm, pelvis 23×35 cm

This last figure, checked and rechecked, is not to be wondered at if it is remembered that by dividing the available surface into areas 4 cm wide, there would be approximately 24 such divisions, or, in its equivalent, 24 portals of entry. However, a portal as small as 4×15 cm is interesting in point of theory, but it proves inefficient for a pelvis 23×35 cm, as will be seen later—a portal 9×15 cm, with a surface intensity of 70 per cent for a depth intensity of 100 per cent, proving itself more suitable for clinical application. A 9×15 cm port is equivalent after a division of available surface to an 11-port technic. In point of execution, however, it is essentially a two-port technic, the tube travelling from one side to the other as a single port, and, with the pelvis turned, the other surface is irradiated as through a single port.

The values in Table I were obtained by placing the paraffin pelvis on the table with tube in the true lateral position, and the table top elevated until the depth center of the pelvis coincided with the radius center of the tube mount. No other adjustment was required. Simultaneously, with the full activation of the tube at 200 kv p, the motor for moving the tube mount was started. When the tube mount reached the true lateral position on the opposite side, having passed

taken from a Victoreen, first, in the center of the pelvis for depth dose, and next, over five spaced areas on the upper surface. To these direct values were added the lesser back-scatter values that came through the pelvis when it was turned with the lower side up, and the ionization chamber on the down side.

It was expected that the values over the sides of the pelvis would be higher than the values over the upper and lower surfaces because the target-surface distance was 52.5 cm to the sides, and 58.5 cm to the top surface of the pelvis. Yet, the values on the lateral surface proved to be, in spite of the shorter focal distance, lower than the upper and lower surfaces. The most important cause for this interesting discrepancy lies in the fact that back-scatter on either side from its opposite side, 35 cm removed, is considerably less than the back-scatter from top to bottom, 23 cm removed.

While this discrepancy in values over the sides and upper surfaces is an inconsiderable one for the smaller portals of entry (Figs 2 and 3), for values representing total spot skin intensity, the highest values obtained are tabulated in Table I. For depth intensity, the values obtained were the same with irradiation of either the upper or lower surface, and the figures

were likewise added to each other for total depth dose upon irradiation of both surfaces

The reasons for the small surface intensity with a high depth intensity would appear to be as follows

1 The utilization of every inch of regional surface, with consequent distribution of surface dose over a larger area, in methods of irradiation other than by mechanical contrivance to direct beam, it is unsafe not to have areas of skin between ports free from irradiation to prevent undue overlapping

2 With the skin divided into 9×15 cm divisions (the largest port size found feasible with this technic), the tube travels through 11 such divisions when revolving about a pelvis 23×35 cm. In spite of the skin dose per equivalent portal area being smaller, the increased number of portal areas available make for an increased depth dose

3 The increase in tube-target distance from the usual 50 cm to a distance varying from 52.5 to 58.5 cm, increases the depth dose. It is felt that, this is the least of the factors involved, since the depth intensities could be increased by only a few per cent for this added distance

Satisfied as to the margin of safety present for the skin, the distribution of intensity throughout points in the pelvis other than the center was next determined. Holes were drilled at various depth levels from the surface to the depth center in various planes, and into these the ionization chamber was inserted in succession. In order not to affect materially the bulk of the paraffin pelvis by the number of holes that had to be drilled, all the holes except the one into which the chamber was inserted for the particular reading were plugged by candles of equal diameter.

From Table I, it is evident that the smaller the portal the less the surface intensity required for a center pelvis intensity of 100 per cent, and as a result, the 4×15 cm port would appear the most desirable. However, the measurement of points throughout the pelvis other than

the center reveals a rapid falling off in values at points off-center with a port 4×15 cm, but a maintenance of high intensity in points off-center when a portal

TABLE I—MEASUREMENT OF r-UNIT INTENSITY SURFACE AND DEPTH CENTER OF PELVIS 23×35 CM WITH ONE COMPLETE REVOLUTION* OF TUBE

Port (cm)	Surface**	r-units	Depth	Surface per cent Depth Intensity
4×15	$(4.0 + 0.5) = 4.5$	4.5	9.0	50
9×15	$(8.5 + 2.0) = 10.5$	10.5	15.0	70
11×15	$(10.5 + 3.0) = 13.5$	13.5	16.0	84
15×15	$(12.5 + 4.5) = 17.0$	17.0	18.5	92

* Because of the number of readings required motor was geared up so that tube revolved completely about table in six minutes instead of forty

** (Direct point surface value + backscatter from r radiation of opposite side) = total point surface value.

9×15 cm or larger is used. The explanation for this is self-evident—the center of the radius within the pelvis is not truly a point center but is an approximate area that corresponds in size to the width of the portal of entry. With the 4×15 cm port the radius center would be about 4 cm wide, and this only would be the area of maximum intensity. With a 9×15 cm port, the radius center is approximately 9 cm wide, accounting for the high intensity maintained in a larger area, continuing, the 11×15 cm port yields an area of greatest intensity that includes almost the entire pelvis in its antero-posterior diameter. Thus, while the 4×15 cm port yields too small an area of maximum intensity in the center of the torso, the 11×15 cm port or larger, yields an area of maximum intensity too large and which encroaches upon the immediate subcutaneous areas with an intensity that is more than proportionately higher.

A study of the distribution chart for a port 9×15 cm (See Chart 3) reveals a radiation intensity distribution that appears satisfactory and advantageous. In the center of the pelvis, throughout an area approximately 11.0 cm in diameter, the intensity is 100 per cent diminishing to 95 per cent peripherally. On the periphery

of a still larger area from the center radius, and 16 cm in diameter, the intensity is still 85 per cent and from there out there is a gradual fading out peripherally toward the surface, the intensity of which is 70 per cent on the upper surface and 62 per cent on the lateral surface. We have, then, the greatest intensity in the potential tumor area and the least intensity in normal tissues. This is a highly desirable distribution of intensity and certainly an unusual one for irradiation of external surfaces where the usual distribution is one of 100 per cent on the surface with a diminution of intensity toward the center.

From these values it is apparent that for a pelvis of average size and an area to be irradiated located in the midline and center of the body, the portal of entry should not be larger than 9×15 cm, but that if the area requiring an intense irradiation permits, a smaller portal might be used profitably to spare even further the normal tissues. Because this technic enjoys its greatest advantage with smaller ports, one should endeavor at all times, if accurate localization of a tumor is possible, to use the smallest adequate port size. A tumor of the bronchus might best be irradiated with a port perhaps 6×15 cm, while a growth of the cervix uteri might require a portal 9×15 cm. Of equal importance to the small skin dose with high depth dose possible with a moving-tube technic is this ability to select a port size for a given pelvis size to achieve an intensity distribution that confines as much as possible the maximum intensity to the tumor area, or rather, to the direct topography and invasive characteristics of the tumor, sparing as much as possible the normal tissues. Under unusual circumstances, one might use a 9×15 cm port over one surface and a 4×15 or 6×15 cm port over the other surface. This may appear to be drawing the line too fine, since it involves a degree of localization not usually possible.

Regarding the actual r-unit delivery with the different portals of entry, by reference to Table I, it can be noted that, apart

from the 4×15 cm port, there is no great difference in quantity between ports 9×15 , 11×15 , or even 15×15 cm. For 15 r-units delivered into the center of the pelvis with a 9×15 cm portal, only 16 r-units will be delivered for the same unit of time if the portal used is 11×15 cm, and only 18.5 r-units if the portal size is 15×15 cm. This difference would never influence decision in favor of a large portal because of an economic complication. From every point of view, the use of a portal 9×15 cm is satisfactory for the pelvis of average size, and is considered the largest port to be used with this pelvis.

In a larger pelvis with a greater anteroposterior diameter and a greater centricity of the body, a port larger than 9×15 cm might be used, perhaps 11×15 cm, depending on the size of the pelvis and the area to be irradiated. Conversely, with a pelvis smaller than 23×35 cm, a portal 9×15 cm would be too large. This supposition was tested by reducing the size of the pelvis to 20×35 cm and measuring the intensity distribution with a port 9×15 cm. (See Table II.)

TABLE II—CENTER, OFF-CENTER, AND SURFACE INTENSITY IN PERCENTAGES

<i>Pelvis 23 × 35 cm</i>							
		5 5 cm Ra- dius*	7 5 cm Ra- dius	9 5 cm Ra- dius	13 cm Ra- dius	Up- per face	Lat- eral Sur- face
Portal (cm)	Center						
4×15	100	70	63	58	53	50	42
9×15	100	95	85	75	70	70	62
11×15	100	104	100	100	84	84	66
<i>Pelvis 20 × 35 cm</i>							
9×15	100	102	80	69	67	70	45

* The radius does not represent a true circle, it increases laterally following the configuration of the pelvis.

Because the area of greatest intensity does not occur in the center of a pelvis 20×35 cm in size, when irradiated by a 9×12 cm port (See Table II), there follows from this, the conclusion that the smaller the anteroposterior diameter, the smaller the portal to be used, that a pelvis smaller than 23×35 cm requires the use of a portal smaller than 9×15 cm. Fur-

ther, the deduction appears feasible that with larger pelves, portals larger than 9×15 cm can be used. Having established that portal of entry yielding a proper radiation distribution within a pelvis of average size, it now remains to be determined how much increase or diminution in portal size will be entailed in adapting this technic to every size of pelvis. Possibly a portal range from 6×15 cm to 11×15 cm will be found to suffice for all variations in size. Further study in this direction is planned, and also, the adaptability of this technic for creating areas of maximum intensity eccentric to the body axis. Here again, it will become a question of proper port size, and perhaps, combination of port sizes.

Pending this further study of pelves other than average in size, it is no great presumption to state that, although very thin pelves can be advantageously irradiated by this technic after the proper port size is determined, it is in the pelvis of greater than average rotundity and anteroposterior diameter that this technic will have its greatest applicability. This is a fortunate circumstance because the thin pelvis offers no great problem for its adequate irradiation with conventional technic, it is with the large pelvis that difficulty arises in the delivery of adequate depth intensity. With the patient's body more rotund, more skin surface is available for portals of entry, with unfortunately, the tumor more remote from the surface. Here most of all is it difficult to angle manually the small port for the deep, invisible tumor so that the extra skin surface cannot be properly utilized. In a moving-tube irradiation, the patient's bulk does not offset the advantage of increased skin surface for portals of entry, and it is felt that as great an intensity can be delivered into the depth center with small skin intensity

Where beams converge there is overlapping, and the center of the pelvis being the point of greatest convergence, the greatest overlapping is there present, with the highest irradiation intensity. From the center of the pelvis outward to the periphery, the convergence and overlapping is lessened and the intensity is lessened, until, at the surface, the overlapping is least and hence the intensity least. Given a larger pelvis, the surface is farther from the center and the overlapping on surface and subcutaneous areas is less than on a small pelvis. The diminution in intensity of the individual beam that occurs with the greater depth is compensated for by the increased amount of skin available for portals.

From the point of view of economy of effort this unit proves of advantage. Instead of changing the tube inclinations for four or six ports, and slowly increasing the voltage each time to its maximum, the patient's set-up is that of a two-port technic, front and back. The tube is never adjusted to the patient. The table top is merely raised or lowered to bring the tumor area into the center of the tube radius required.

CONCLUSIONS

- 1 Through the use of a tube, moving in an arc about the patient, a high depth intensity with a small surface intensity is made possible.

- 2 A distribution of intensity is achieved wherein the center of the pelvis receives the greatest intensity, with the intensity diminishing peripherally to become the least great on the surface.

- 3 The size of the area of central intensity can be regulated by use of a proportionate portal size.

CASE REPORTS AND NEW DEVICES

SLIT SCANOGRAPHY

By ROBERT H. MILLWEE, M.D., Dallas, Texas

Two factors which add greatly to the difficulty of interpretation of radiographs are

up and down the spine, making a number of radiographs of small portions of the spine on the same plate in such a manner that they would fit together in a composite picture. The idea of moving the tube during exposure

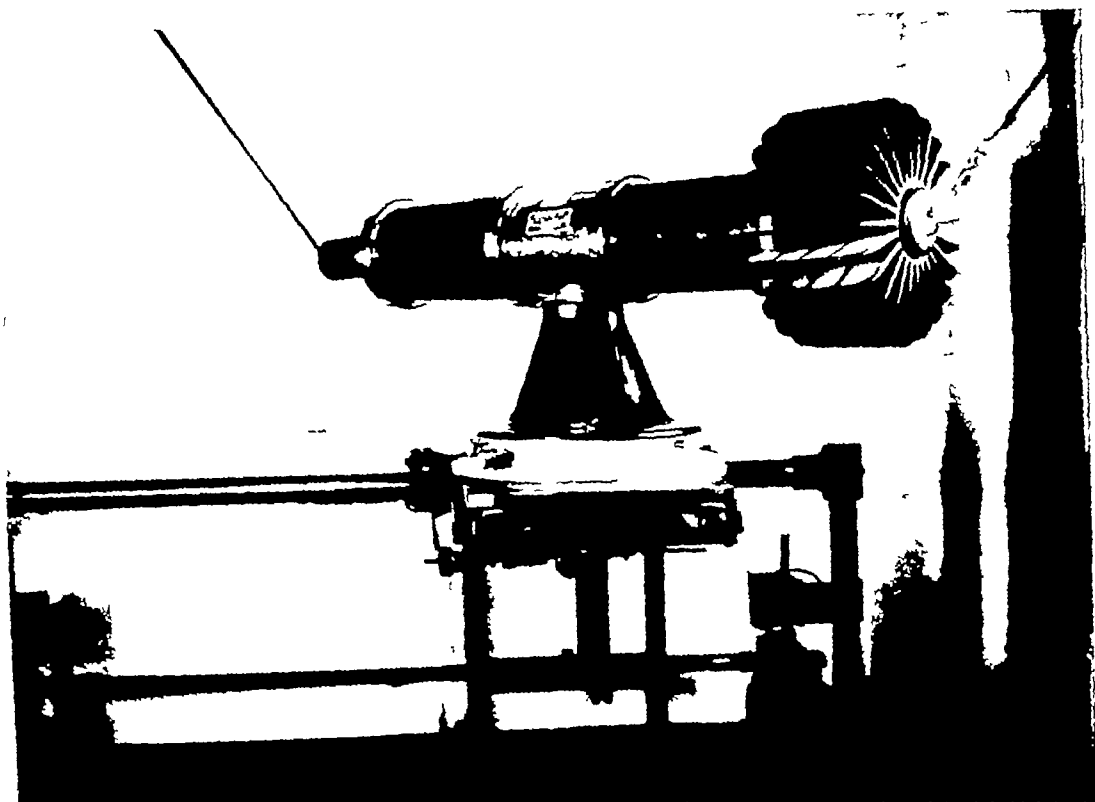


Fig 1 A Photograph of scanographic apparatus which shows the tube mounted on an arm above the table and the motor-driven screw which moves the tube lengthwise of the table

distortion and great variation in thickness or density of various anatomical parts included in single radiographs, as for instance, the toes and ankle, or regions adjacent to the diaphragm.

Much has been accomplished to minimize distortion and irregularity of density, by making multiple exposures from various angles and by the employment of greater plate-target distance.

With a view of further reducing the effects of distortion and variation of density we attempted during the past year the development of some new apparatus of unusual type. We were especially interested in the making of clear radiographs of large portions of the spine, which would more accurately portray the relation of its various parts. My first idea was to develop a method of shifting the tube

was considered, but not attempted, because of the probable loss of detail. Co-operation of the research department of the Kelley-Koett Company was secured, and an apparatus for the work was constructed under the direction of Mr. W. W. Mowry. Mr. Mowry also suggested moving the tube while exposure was being made, and he carried out some experiments. After analyzing the results of this work, our present apparatus was completed by the Kelley-Koett Company, and considerable experimentation has been carried out. The results are in some respects very encouraging, and we believe the idea has certain advantages which deserve the attention of the progressive radiologist.

The apparatus (Fig 1) consists of a regular radiographic table with a side rail and arm to hold an x-ray tube at a plate-target distance

of 25 inches. This tube is driven lengthwise of the table at varying speeds by a motor-driven worm gear. Instead of the regular

This single slit serves the same purpose as a narrow Bucky in absorbing secondary rays. In this way all the central beam of λ rays



Fig 2 A

Fig 2 B

Fig 2 A This is an ordinary radiograph anteroposterior view made to bring out the detail of the tarsal bones. Such a radiograph as is usually the case does not reveal much definition in the distal portion of the metatarsals and phalanges.

Fig 2 B Scanograph of the same foot as shown in Figure 2 A. As the tube travelled from the posterior to anterior portion of the foot the voltage was decreased which produced as good bone detail in the phalanges and thicker portion of the ankle.

circular cone, an adjustable slit is arranged between the tube and patient to take the place of the cone. Hence, as a tube is passed from one end of the table to the other a beam of λ -rays like a narrow sheet, or line of λ -rays traverses the patient. In other words, the tube moves over the part to be radiographed while the exposure is being made. The apparatus is so arranged that all the plate is protected by lead, except that narrow strip which is being exposed. The protecting material is supported by an arm under the table top between the patient and the plate, and this is secured to the tube, moving at the same speed as the tube

passes through the body and reaches the plate from the same angle. Some of the radiographs made by this apparatus are found in Figures 2, 3, 4, and 5.

The method has some advantages. First, an exact measurement of bones or joint spaces is secured, which is of great advantage in a study of bone or joint development; second, it aids in securing better radiographs of parts of the body which vary greatly in thickness or density.

It may give considerable valuable information regarding physiological or pathologic processes which affect the movement of parts or organs such as the heart, diaphragms, pleura,



Fig 3 A



Fig 3-B

Fig 3 A Ordinary anteroposterior radiograph of the lumbar spine which reveals the usual distortion

Fig 3-B A scanograph of the same lumbar spine, the tube having been shifted lengthwise of the spine during exposure which eliminates distortion in the vertical direction giving the accurate vertical widths of the vertebral bodies and intervertebral spaces

or chest wall, as are now studied by the kymographic method. Exact measurements of the heart, pelvic outlet, or fetal head are secured, all of which are difficult to obtain by other methods.

Foreign bodies may be more accurately located.

The exact extent of bone pathology may be more accurately determined.

Distortion in one direction is entirely eliminated by this method, so if radiographs are made by shifting the tube in one direction and then a second radiograph is made shifting the tube at a right-angle to the first shift, distortion is completely eliminated.

Further development of this idea may produce radiographs entirely void of distortion in all directions.

An excellent radiograph may be made of a part which varies greatly in thickness or density by varying the speed of the travelling rate of the tube, or by varying the voltage of current through the tube with variation of density of the part being radiographed.

I have given this method of making radiographs the name "Slit Scanography." The word "scanography" was suggested to me by Dr. Wendell G. Scott, of Washington Uni-



Fig 4-1

Fig 4-1 An ordinary radiograph of a heart which reveals a slight enlargement of the heart on the left side.



Fig 4-B

Fig 4-B A scanograph of the same heart as shown in Figure 4-A which reveals a large tumor mass to the right side of the midline. This tumor is made visible in the scanograph because of the fact that the right side of the heart in this case seems to empty and fill completely with each heart cycle and the tumor mass does not empty. Hence the greater difference in density which condition does not exist in the case of the ordinary radiograph. In other words, the variation in density during diastole and systole is recorded on the film. The left border of this heart moves as recorded in the scanograph, but the variation in density of the heart and muscle on the left side is not recorded as in the case on the right side in this heart. This patient was clinically a case of aortic stenosis, hence the lack of change of density of the left side of the heart as shown in the scanograph may be due to either hypertrophy of the heart muscle on the left side or the heart may never become completely emptied of blood during systole because of aortic stenosis.



Fig 5 A case of mitral stenosis which reveals a typical enlargement of the left side of the heart. However, the difference in density during diastole and systole indicates that the ventricles are probably emptied completely during systole.

versity "Scan" is defined by Webster as "to go over and examine point by point, to examine with care, to look close at or into"

Several difficulties must be overcome before scanography will be successfully employed for heavy parts like lateral views of lumbar spines, and one of these difficulties is the development of a tube of sufficient capacity. For instance, we need a tube to take 100, or preferably 200 ma at 80 kv for several seconds. We are now experimenting with the use of three tubes placed parallel with one another, with parallel slits, so that the distance which the tube must travel may be materially reduced. The great difficulty in this procedure is to avoid overlapping of rayed areas.

SARCOMA OF THE STOMACH

A REPORT OF TWO CASES

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An extensive and scattered literature has grown about the subject of sarcoma of the stomach. The clinical diagnosis of this lesion remains the exception rather than the rule. Accordingly the following instances of sarcoma of the stomach are deemed worthy of record.

Case 1 W. M., a white male, 59 years old, was first admitted to the State of Wisconsin General Hospital on March 31, 1936. His present illness dated from March 19, 1936, at which time he passed a large tarry stool. He felt weak and had to go to bed. A physician was consulted and he advised a light diet and bed-rest. There was no pain, nausea, or vomiting. History by systems revealed occasional vertigo, tinnitus, palpitation, dyspnea, and fatigue. There had been a 20-pound weight loss within ten days. The past medical history evolved no pertinent findings.

On physical examination a marked pallor of the skin was noted. The pupils reacted poorly to light and accommodation. The heart was within the upper limits of normal in size. Aortic and mitral systolic murmurs were heard. The blood pressure was 150/90. The liver was palpable 6 cm. below the right costal margin.

The urinalysis was essentially normal. Blood study showed a hemoglobin of 48 per cent, red blood cells, 2,540,000, white blood cells, 7,200, with a normal differential count. The blood Wassermann reaction was negative.

A roentgen-ray examination after a barium enema showed a normal colon. A gastrointestinal series was commenced but the patient fainted before upright fluoroscopy could be completed and the examination was done largely with the patient in the recumbent

position. The esophagus was normal. There was a small area of translucency, brought out only by palpation, in the central portion of the stomach just below the incisura angularis and toward the greater curvature side. There was a break in peristalsis on the greater curvature opposite this area. The rugæ were markedly thickened in the central and distal portions of the stomach and in addition to the larger area of translucency, there were several smaller ones in the immediate vicinity. No ulcer crater could be demonstrated in the stomach or the duodenal bulb. The roentgenologic impression was that of polypoid lesions.

Following the completion of his diagnostic study the patient was discharged and later readmitted on May 5, 1936. He had regained strength in the interval and there had been no further hemorrhage from the bowel. An exploratory laparotomy was performed on May 14, 1936. A hard nodule was palpated through the gastric wall in about the mid-portion. An incision was made in the anterior wall of the stomach, a forceps introduced and the mass brought out through the opening in the stomach. Examination revealed a puckering of the mucosa at this point, which was felt to represent an ulcer scar. A gastric resection was then done followed by an entero-anastomosis after the Polya modification of the Billroth II type. The post-operative course was uneventful.

Examination of the excised portion of the stomach revealed a small superficial ulcer 5 mm in diameter surrounded by localized hypertrophy of the mucosa. A firm nodule could be palpated beneath the ulcer and, on section, this appeared well circumscribed and about 1 cm in diameter. Professor C. H. Bunting, of the Department of Pathology, has kindly reported his study of this tissue as follows:

"The section shows a lightly stained tumor mass apparently originating in the submucous coat. The tumor appears slowly growing but has invaded in both directions, extending inward into the mucosa and outward through the muscle coat into the subserous layer. The cellular content is somewhat variable. Certain cells are of spindle character, others are rather pleomorphic, with polyhedral tendency, with relatively large vesicular nucleus and distinct nucleolus, and with considerable deeply staining protoplasm with numerous minute punched-out vacuoles, apparently fat vacuoles. These resemble in appearance embryonic fat cells. Other cells are of a small signet-ring type. Our conclusion is that the tumor is of the nature of a liposarcoma."

Case 2. Mrs. K., a white female, 44 years old, was admitted to the State of Wisconsin General Hospital on April 16, 1936, complain-

ing of pain in the left side of the abdomen. The pain had had a sudden onset on April 1, and a dull throbbing had persisted with alternately sharper pain in the left upper quadrant. On further questioning the patient stated that she had experienced some abdominal distress and dull epigastric pain with periods of exacerbation since 1908. An appendectomy had been performed in that year without relief of the symptoms. In 1927 cholecystectomy had been done and two stones were found in the gall bladder. At no time during this protracted history had there been hematemesis, but the stools were tarry on March 16, 1936. This blood loss continued for one week, but there has been no recurrence since. For the past ten years or more she had been on a modified Sippy diet from time to time. Weakness had advanced and since the middle of March, 1936, she had been confined to bed almost continuously.

At present the sharp pain which superseded the persistent dull throbbing pain in the left side was localized to an area about five centimeters in diameter in the left upper quadrant. It recurred a number of times a day. Such attacks lasted from five minutes to several hours. The point of the greatest intensity of the pain was several finger-breadths below the left costal margin in the mid-clavicular line and the pain seemed to traverse to the back. Hot applications offered some relief, but the exacerbations occurred without any known cause.

In the inventory by systems the only details of importance related to an unpleasant taste in the mouth, elaboration of the regular dietary and antacid regimen, indefinite nausea, inability to vomit, abdominal distention with generalized abdominal pain in the middle of March, belching and eructation of gas with the shifting of the localization of pain, as above stated, about April 1. Constipation had been met by the use of mineral oil. There had been weight loss of about eight pounds since March 15. The past medical history established the occurrence of scarlet fever with a complicating nephritis when ten years old, diphtheria shortly thereafter, cow pox in childhood, mumps, whooping cough, and pneumonia in childhood, tonsillitis with frequent quinsy prior to 1920 when tonsillectomy was performed. The social history was irrelevant. The history of the catamenia showed no abnormality except a recent reduction in the flow. The family history was important only in the detail of surgery directed toward peptic ulcer in a sister, 39 years old, who is now said to suffer from gall-bladder trouble.

The physical examination revealed the following pertinent findings. Rather poorly nourished, under developed, pale white female

several palpable axillary nodes, nasal turbinates enlarged, mucous membranes of the mouth pale, slight impairment of resonance poste-

the stomach with rather a peculiar distribution. These shadows are persistent in all films

The urinalysis was essentially normal The



Fig 1



Fig 2

Fig 1 Case 2 Postero-anterior view of stomach The upper third is blanching out from pressure of the mass posteriorly The intact rugae are on the anterior wall

Fig 2 Case 2 Anteroposterior view There is evidence of external pressure on the stomach with nodular protrusions into the lumen Small gas bubbles are seen in the soft tissue mass outside of the gastric lumen

riorly in the upper chest, diminution of the breath sounds at the apices, heart size normal, soft apical systolic murmur untransmitted, splinting of the left upper abdomen upon respiration with peculiar staying of the outward movements of the left costal margin, spasm of the left upper abdominal muscles, exquisite tenderness in the left flank, liver palpable 2 cm below the costal margin, parous vaginal outlet with good support, retroverted uterus, thick creamy vaginal discharge

Gastro-intestinal observations were reported as follows the barium meal passes through the esophagus without delay The fundus of the stomach shows a mottled defect limited to a rather small area on the posterior wall and with an associated mass lying posterior to the fundus and compressing it considerably This region corresponds to the area of maximum tenderness The balance of the stomach fills normally The bulb fills immediately and shows normal outline The films show a stomach of normal size There is blanching of the barium shadow in the upper third due to the presence of the mass posterior to the fundus and a mottled defect involving the posterior wall and adjacent portion of the lesser curvature just below the cardiac orifice No ulcer pockets are visible The bulb is normal and immediate emptying is satisfactory In six hours the stomach is empty of barium and the head of the meal is in the proximal transverse colon Progress through the small intestine has been quite satisfactory There are mottled air shadows in the region of the middle third of

blood count showed a hemoglobin of 55 per cent, red blood cells 3,720,000, white blood cells 8,200 with 83 per cent neutrophils and 17 per cent small lymphocytes The stools were negative to guaiac The blood Wassermann reaction was negative Blood chemistry revealed normal values for glucose and non protein nitrogen

The differential diagnosis lay between a perforating peptic ulcer on the posterior wall of the cardiac end of the stomach and a neoplasm in this location and, interestingly, the clinical opinion favored a perforating ulcer, while the roentgenologic judgment was carcinoma of the stomach with necrosis

In either event, surgical interference was deemed imperative and accordingly four days after discharge from the State of Wisconsin General Hospital, Dr O E Satter, of Prairie du Chien, performed a laparotomy with the following results On the greater curvature of the stomach about three inches from the cardiac orifice there was found a malignant diverticular mass about three and one-half inches in diameter The omentum was drawn down around the mass to wall off a recent partial perforation There seemed to be an actual outgrowth from the posterior curvature of the stomach that admitted two fingers and then dilated into a necrotic cavity This diverticular mass was excised from the stomach wall and the opening into the stomach closed The patient succumbed shortly thereafter

Professor C H Bunting has kindly rendered the following histologic description and opinion

"The section of the stomach wall shows an extensive chronic ulcer, subtended by granulation tissue with a superficial, quite dense, fibrinous exudate. At many points there is invasion of the ulcer base by tumor cells of a spindle shape. These are grouped in many places in a palisade arrangement suggestive of the picture presented by a neurogenic sarcoma. However, deeper in the stomach wall the tumor consists of interlacing bands of spindle cells without the palisade arrangement but grouped in interlacing bundles. In certain areas these cells are continuous with more normal bundles of smooth muscle cells, and it is concluded that the tumor is of this order and to be diagnosed as a myosarcoma, of origin in the muscle coat and with marked invasion throughout the layers of the stomach wall."

DISCUSSION

Essentially these two patients presented distinctly different clinical pictures. Melena occurred in both. While this symptom dominated the picture in Case 1, it was subsidiary in Case 2. The recent order and severity of the gastro-intestinal hemorrhage characterized Case 1. In Case 2, pain of an altered type had suddenly supervened in a patient who for years had experienced abdominal distress and epigastric pain. The nature and reference of the recent pain in the left upper quadrant of the abdomen had suggested the clinical diagnosis of a perforating gastric ulcer in the posterior wall of the stomach.

In the light of subsequent developments, the roentgenologic findings are of especial significance. In Case 1, syncope rendered an adequate examination impossible, but an area of translucency in the central portion of the stomach developed by pressure led to the conclusion of a gastric polyp. This opinion was strengthened by the occurrence of several smaller areas of translucency adjacent to the one described. The roentgenologic findings in Case 2 were even more arresting. The filling defect in the posterior wall of the fundus was associated with a mass and the intragastric protrusion of the same led to a division and diversion of the barium meal as it entered the stomach. The mottled air shadows which persisted at the site of the palpated mass gave force to the suggestion of a necrotic tumor in communication with the stomach. No explanation for the failure of barium to enter such a pathway was offered at the time of the examination. It is significant, however, that the clinical staff favored an inflammatory background while the roentgenologist maintained a neoplastic diagnosis. Drane's comment in this relation (1) is particularly pertinent: "The roentgenologist was the first to definitely pal-

pate a mass. He was in error in saying that it was a carcinoma and inoperable, but correct in maintaining that it was malignant and not a perforated ulcer with inflammatory mass deforming the stomach."

Admittedly in the present state of our knowledge of the subject the accurate clinical diagnosis of sarcoma of the stomach is the unusual exception. As a rule the symptoms, clinical course, and physical findings conclude a diagnosis of gastric carcinoma unless there be a more or less removed but recognized lymphosarcoma with subsequent evidences of involve-



Fig 3 Case 2 Multiple small gas bubbles visible in the region of the tumor considered indicative of necrosis within the mass

ment of the stomach. So remote is the chance of the clinical diagnosis of a primary sarcoma of the stomach, and yet so important from the standpoint of prognosis and management is its recognition, that every effort should be exerted to improve our diagnostic facility in this condition.

Since roentgen examination apparently offers the only immediate prospect of assistance in this direction, we may with profit consider certain of the details which promise diagnostic advantage. D'Aunoy and Zoeller (2) conclude that "x-ray examination will usually furnish evidences of a gastric neoplasm but does not

give information enabling a positive diagnosis of sarcoma." Balfour and McCann (3) report the roentgenologic examination of 45 cases of sarcoma of the stomach in which the conclusions were malignant lesion, 35, ulcer, 5, extra-gastric tumor, 2, possible benign tumor, 1, negative, 5. Importantly, they report operability in two of eight patients adjudged inoperable by roentgen examination. Two pre-operative diagnoses of sarcoma of the stomach were rendered and one roentgen diagnosis of lymphosarcoma was confirmed at operation. However, no guideposts are offered for this conclusion. Kessler (4) suggests that, in general, gastric sarcoma is not susceptible of regular roentgenologic diagnosis. She excepted the exogastric type of sarcoma which might conceivably lead to a large pressure defect in the stomach. Pack and McNeer (5) point out the improbability of obstruction of the orifices of the stomach by sarcomatous lesions in contrast to the proclivity of carcinomas in this direction. They furthermore indicate the directional significance of giant rugæ in lymphosarcoma and of the persistence of gastric peristalsis in the presence of a recognized lesion. Case (6) recently reviewed the reported instances of diverticulous sarcoma of the stomach (three) and added a case of his own, in which a diagnosis of "an ulcerating lesion with tumor formation" was made from the roentgen findings of a half-inch crater in the middle third of the stomach surrounded by a filling defect. Our Case 2 adds the persistent motting of air bubbles at the site of the palpated mass to the filling defect and evident intra-gastric protrusion as meager supportive details for the diagnosis of this unusual condition of diverticulous sarcoma.

CONCLUSIONS

Two cases of sarcoma of the stomach are recorded in the hope of stimulating a concerted movement toward a registry of cases of this type. While our interest is primarily diagnostic, the prognosis of this neoplasm adequately treated is definitely better than that of gastric carcinoma. Hence it would appear logical to seek an earlier and clearer differential diagnosis between these confusing pictures.

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OXYCEPHALY

REPORT OF CASE

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Since Van Graefe, in 1886, first recognized and described this uncommon anomaly of the skull, much has been written concerning its various phases, and many cases have been reported. Noteworthy contributions to the literature of oxycephaly have been made in recent years by Grieg, Schuller, Bronfenbrenner, Jacobsen, and Fletcher. It is only because of the paucity of mention of this condition in the roentgenologic literature that this case is being presented.

Oxycephaly is a skull deformity secondary to premature synostosis of the cranial sutures. Normally these sutures are not obliterated until the sixth or seventh decades of life. When this fusion of cranial bones occurs in intra-uterine life, or in the first year of post fetal life, the skull is prevented from growing and expanding in the usual normal manner. Instead, due to the inherent growth pressure of the brain, it expands at the points of least resistance (usually the anterior fontanel), and gives rise in time to a skull deformity with more or less definite morphologic characteristics.

The typical oxycephalic head is abnormally high, with a steeply rising forehead and a blunt, dome-like apex at the site of the anterior fontanel. The globella, supra orbital ridges, and frontal eminences are flattened out. There is usually a widening of the transverse and a narrowing of the anteroposterior diameter of the skull. Exophthalmos is a common feature due to a shortening of the anteroposterior diameter of the orbits. This is frequently associated with a divergent squint.

According to Jacobsen,

The occiput is almost flat. The forehead is flat or may even appear concave with small superciliary ridges. The temporal regions bulge. The orbital openings are wide but the cavities are shallow causing the eyeballs to protrude. The maxillary and zygomatic bones are poorly developed and the palate is highly arched. The body of the mandible may be strongly formed but the ascending ramus, neck, and condyle are under developed. The teeth are crowded because of the narrow palate and mouth breathing usually results from the malformation of the rhinopharynx. The accessory nasal sinuses are small or absent.

REPORT OF CASE

W B, colored male, aged 9 years, was admitted to John Gaston Hospital on Aug 20, 1936, with complaint of a peculiarly shaped head since one year of age, and of backwardness

the occiput and tapering symmetrically to a narrow, pointed chin. The unusual height of the head and a large dome-like mound at the site of the anterior fontanel are its most striking characteristics. The glabella, super-



Fig 1 Frontal and lateral photographs of patient

at school. A "tumor" was first noticed on the child's head when he was one year of age. This had grown progressively larger and more prominent. The boy was not as bright as his brothers and sisters. He has gone to school since he was six years old, and now, at the age of nine, he is still in the first grade.

Birth History—Normal, full term, spontaneous, no instruments, weight seven pounds, six ounces, condition good.

Developmental History—Bottle-fed, sat up at six months, stood at eleven months, talked at one year, first teeth at four months.

Family History—Mother living and well. Father dead, of dropsy, at age of 50. Two brothers and one sister living and well, all normal. Family denies venereal history, no history of similar cases in family.

Past History—Measles at eight years, whooping cough at two years.

Physical Examination—Patient is a fairly well nourished colored male, aged 9, height $52\frac{1}{4}$ inches, weight $60\frac{1}{2}$ pounds, rational, cooperative, and friendly. He is, as Courbon has described a case of his, "calm, docile, apathetic, and indifferent." His response to questioning is slightly delayed but shows clarity of thought. His reactions to his surroundings are not those of a normal boy. At nine years of age, he is in the first grade at school, knows the alphabet, and can write his name. He talks with a nasal twang to his voice. He is apparently a mouth-breather. The head is shaped much like an egg, widest at

ciliary arches, and frontal eminences are markedly smoothed out. The forehead rises at an angle of about 45 degrees and slopes steeply upward toward the bregma. At the site of the anterior fontanel is a large bony knob about the size of half a golf ball which marks the highest point of the skull. Along the course of the metopic, coronal, and sagittal sutures, definite raised ridges may be felt (Fig 1).

MEASUREMENTS OF THE HEAD

Circumference	53.0 cm
External auditory meatus to external auditory meatus	37.5 cm
Inion to occipital point	5 cm
Forehead to occipital point (calipers)	21 cm
Inion to occipital point (calipers)	5 cm
Biparietal width (calipers)	17 cm
Bizygomatic width (calipers)	13 cm
Basal bregmatic height (from roentgenograms)	18 cm
Basal alveolar length (from roentgenograms)	9.3 cm

$$\text{Cephalic index} = \frac{\text{Breadth} \times 100}{\text{length}} = \frac{17 \times 100}{21} = 80.9 -$$

brachycephalic or short headed

Horizontal index of normal head is 80.0, above that, is in brachycephalic or short-headed group

$$\text{Vertical index} = \frac{\text{Height} \times 100}{\text{length}} = \frac{18 \times 100}{21} = 85.2 -$$

hypsocephalic or high headed

Vertical index of normal head is 70.0, above this is in the high headed group

There is a definite bilateral, symmetrical exophthalmos, but no strabismus. Extraocular muscles are normal. There is no limitation of the fields of vision. Pupils are equal and regular and react to light and accommoda-

give information enabling a positive diagnosis of sarcoma." Balfour and McCann (3) report the roentgenologic examination of 45 cases of sarcoma of the stomach in which the conclusions were malignant lesion, 35, ulcer, 5, extra-gastric tumor, 2, possible benign tumor, 1, negative, 5. Importantly, they report operability in two of eight patients adjudged inoperable by roentgen examination. Two pre-operative diagnoses of sarcoma of the stomach were rendered and one roentgen diagnosis of lymphosarcoma was confirmed at operation. However, no guideposts are offered for this conclusion. Kessler (4) suggests that, in general, gastric sarcoma is not susceptible of regular roentgenologic diagnosis. She excepted the exogastric type of sarcoma which might conceivably lead to a large pressure defect in the stomach. Pack and McNeer (5) point out the improbability of obstruction of the orifices of the stomach by sarcomatous lesions in contrast to the proclivity of carcinomas in this direction. They furthermore indicate the directional significance of giant rugae in lymphosarcoma and of the persistence of gastric peristalsis in the presence of a recognized lesion. Case (6) recently reviewed the reported instances of diverticular sarcoma of the stomach (three) and added a case of his own, in which a diagnosis of "an ulcerating lesion with tumor formation" was made from the roentgen findings of a half-inch crater in the middle third of the stomach surrounded by a filling defect. Our Case 2 adds the persistent motting of air bubbles at the site of the palpated mass to the filling defect and evident intra-gastric protrusion as meager supportive details for the diagnosis of this unusual condition of diverticular sarcoma.

CONCLUSIONS

Two cases of sarcoma of the stomach are recorded in the hope of stimulating a concerted movement toward a registry of cases of this type. While our interest is primarily diagnostic, the prognosis of this neoplasm adequately treated is definitely better than that of gastric carcinoma. Hence it would appear logical to seek an earlier and clearer differential diagnosis between these confusing pictures.

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OXYCEPHALY

REPORT OF CASE

By DAVID BENNETT DAVIS, M D
Resident Pediatrician and J CASH KING, M D,
Roentgenologist John Gaston Hospital
Memphis Tenn

Since Van Graefe, in 1886, first recognized and described this uncommon anomaly of the skull, much has been written concerning its various phases, and many cases have been reported. Noteworthy contributions to the literature of oxycephaly have been made in recent years by Grieg, Schuller, Bronfenbrenner, Jacobsen, and Fletcher. It is only because of the paucity of mention of this condition in the roentgenologic literature that this case is being presented.

Oxycephaly is a skull deformity secondary to premature synostosis of the cranial sutures. Normally these sutures are not obliterated until the sixth or seventh decades of life. When this fusion of cranial bones occurs in intra-uterine life, or in the first year of post fetal life, the skull is prevented from growing and expanding in the usual normal manner. Instead, due to the inherent growth pressure of the brain, it expands at the points of least resistance (usually the anterior fontanel), and gives rise in time to a skull deformity with more or less definite morphologic characteristics.

The typical oxycephalic head is abnormally high, with a steeply rising forehead and a blunt, domelike apex at the site of the anterior fontanel. The globella, supra-orbital ridges, and frontal eminences are flattened out. There is usually a widening of the transverse and a narrowing of the anteroposterior diameter of the skull. Exophthalmos is a common feature due to a shortening of the anteroposterior diameter of the orbits. This is frequently associated with a divergent squint.

According to Jacobsen,

The occiput is almost flat. The forehead is flat or may even appear concave, with small supraciliary ridges. The temporal regions bulge. The orbital openings are wide but the cavities are shallow causing the eyeballs to protrude. The maxillary and zygomatic bones are poorly developed and the palate is highly arched. The body of the mandible may be strongly formed but the ascending ramus neck, and condyle are under developed. The teeth are crowded because of the narrow palate and mouth breathing usually results from the malformation of the rhinopharynx. The accessory nasal sinuses are small or absent.

and mastoid sinuses, with impaired development or narrowing of these sinuses

(2) Sequelæ of increased intracranial pressure, namely,

- (a) Deep convolutional digitations in all skull bones
- (b) Extensive thinning of calvarium, more marked at points of least resistance, *i e*, anterior fontanel

Dr Francis Murphey, neuro-surgeon in attendance, advised right subtemporal decompression. This was done on Aug 27, 1936, under ether anesthesia. Recovery was uneventful and the patient left the Hospital on Sept 6, 1936, in good condition. Seen at subsequent visits, the patient's condition is satisfactory and presents no significant clinical change although the mother claims that the child is much more alert and active since the operation.

CONCLUSIONS

Striking cases of premature synostosis of cranial sutures such as the one herein reported are not likely to go undiagnosed. However, it would seem probable that many of the milder cases are overlooked, especially those developing late, in which the deformity is mild and in which a thick head of hair may mask the picture. Unexplained exophthalmos, with even slight skull deformity or divergent squint, should be sufficient to excite suspicion and to justify obtaining x-ray plates of the skull in order to rule out oxycephaly.

LAMINATED KIDNEY STONES

By D R HANLEY B S M D Roentgenologist St Mary's Hospital *Streator Illinois*

After an extensive survey of the entire medical literature I have been unable to find a single contribution in respect to laminated kidney stones. Whether or not this is the first case reported, is of no great consequence, however, such stones constitute a rare finding. Laminated kidney stones are referred to in certain texts, but they all show cross-sections of the stones with laminations internally, none showing their true organic nature throughout. Instead, their true organic matter is overshadowed by some crystalline substance. These stones present lamination not only internally but externally as well.

There is no insurmountable difficulty in explaining the growth of such stones when once started, but it is more difficult to explain their origin. Some are formed around foreign bodies, etc., but most calculi, whether found

in the renal pelvis or in the bladder, are formed originally in the tubules of the kidney. This is especially true of uric acid stones, because they are the most common and because the conditions found in the so-called uric-acid infarcts of the kidneys explain their origin fairly well. These infarcts are found frequently in the kidneys of children, and produce a yellow streaking of the papilla of the pyramids and sometimes have actual stony concretions embedded in ragged cavities near the tip. This is due to the abundant excretions of uric acid by the cells of the tubules. The uric acid appears in minute, round spheruliths which become massed together with an albuminous material, secondarily gluing them together, forming the primary concretion.

The application of new layers of crystals to the concretion already formed is thought to occur just as rock candy crystallizes on the string, but it involves the idea of an oversaturation of urine with crystalline substances in solution. So, if the urine is acid, boric acid may crystallize out, while if it is alkaline, phosphates, ammonio-magnesium phosphates, and ammonium urates may appear. Something may cause the precipitation of those colloid materials in the urine which tends to hold the uric acid in solution, after which it produces ammonical decompositions of the urine, and is favorable to the formation of phosphatic concretions.

CASE REPORT

The following data are in detail from the patient's history as taken by the interne on the urological service with an admitting room diagnosis of pyelohathiasis.

Patient J M J, single, white, American male, weighing 175 pounds, age 27 years, and a machinist by occupation. The patient stated that he was well and working every day until March, 1932, when he was stricken with a sudden pain on the left side below the ribs. The pain was knife-like in character and was exaggerated greatly when the patient was stooping or bending. Unable to go to work, he went to bed, the following day he seemed to be distended and was in more pain. The family physician was called, and he made a diagnosis of possible intestinal obstruction, advising hospitalization. This disturbed the patient greatly, but he refused to go to the hospital. He remained in this state for about two months, although he felt well enough to return to work. Following a New Year's Eve orgy he was stricken with a severe pain in the left upper quadrant and on New Year's Day was taken to the hospital by ambulance.

History by Systems—*Cardiovascular*, essentially negative, *genito-urinary*, no discharge,



Fig 2 Frontal and lateral roentgenograms

tion Examination of the fundi reveals only slight tortuosity of the vessels and no evidence of optic atrophy Ears are normal The bridge of the nose is flat and broad, the alæ nasæ fleshy The teeth are carious, uppers slightly crowded but there is no overlapping The palate is high, arched, and the pharynx is narrow and small There is no cervical adenopathy Thyroid is not palpable Thorax is asthenic, asymmetrical, with a funnel type of chest The right sternoclavicular junction is marked by a large knob, the size of a small walnut, and there is prominent beading of the upper five costochondral junctions on the right side

The lungs are clear, the heart is normal The rest of the physical examination and the neurological examination are essentially normal

LABORATORY FINDINGS

Blood

Red blood cells 4 490 000
White blood cells, 4,200
Polymorphonuclears 71 per cent
Polymorphonuclear eosinophiles 2 per cent
Polymorphonuclear basophiles 1 per cent

Lymphocytes 25 per cent
Monocytes, 1 per cent
Hemoglobin 14.4 per cent
Wassermann test, negative

BLOOD CHEMISTRY

Cholesterol 153.0 mgm /100 c c serum
Non protein nitrogen 17 mgm /100 c c serum
Sugar 84 mgm /100 c c serum
Calcium 9.0 mgm /100 c c serum
Phosphorus 4.2 mgm /100 c c serum
Urine negative
Spinal fluid pressure increased
cell count—2—lymphocytes
Pandy—negative
Kahn—negative

X RAY REPORT (FIG 2)

- (1) Synostosis of all the bones of the calvarium resulting in
 - (a) Marked increase in height of skull and moderate increase in width
 - (b) Extension of middle fossa downward and forward
 - (c) Shortening of anteroposterior diameter of orbital fossæ and increase in their angle of divergence due to pressure from middle and anterior fossa
 - (d) Encroachment upon frontal, ethmoid,

and well formed, lending evidence of many months consumed in their formation. The appearance of the stones was as shown in Figures 1 and 2.

A laboratory analysis of the stones proved them to consist of uric acid, calcium phosphate, and ammonium urates. Each stone contained a single nucleus which gave a positive test for uric acid and xanthin, the laminae gave positive calcium tests, while the remainder was composed largely of urates.

As can be noted from the history of this patient, there is nothing in his mode of living, type of work or rank of society to warrant his having laminated kidney stones instead of the ordinary variety of kidney stones.

A NEW POSITION FOR THE EXAMINATION OF THE LUMBOSACRAL AREA¹

By GAGE CLEMENT M.D., Radiologist, St. Luke's Hospital, Duluth, Minnesota

Ordinarily, in the x-ray examination of the lumbosacral area, the patient assumes a recumbent position on the table. Stereo films in the anteroposterior position, flat films in the two three-quarters oblique positions, and a flat film in the lateral position are probably

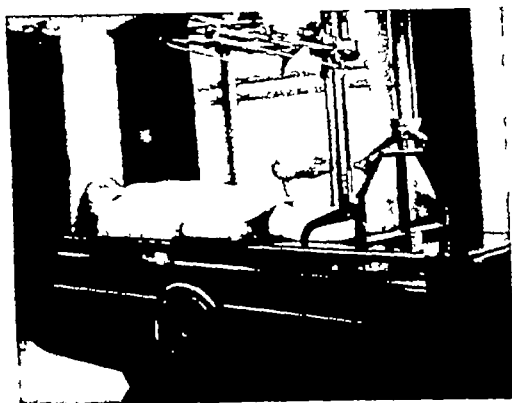


Fig. 1 Patient in usual recumbent position

made. In none of these positions is there any resemblance to the position assumed by the patient while at work, either sitting or standing. This is particularly true in those cases of rather obscure or indefinite back pain. Such recumbent positions do not record the relationship which the bony structures assume with the patient upright and possibly lifting.

¹ Presented before the Radiological Society of North America at the Twenty-second Annual Meeting, at Cincinnati, Nov. 30-Dec. 4 1936.

With this observation in mind, several plans were attempted with the object of revealing the changes which the upright position might produce. All the attempts failed except one, that of having the patient stand, strapped to



Fig. 2 Patient in upright position with sand bags on shoulders

the table, supporting a 25-pound sand bag on each shoulder. This is the plan in use to-day.

The technic is as follows. The patient is placed in the usual recumbent position on the x-ray table. His feet are against the foot rest. The compression band is secured across the middle of the thighs and tightened. The tube is placed as nearly as possible over the central part of the upper pelvis, determined by centering over the middle of a line drawn from one anterior superior iliac spine to the other. The central beam is directed to it at right-angles. The center of the movable grid is placed in the path of the central beam and the cassette is placed in the center of the grid pan. In this position the first film, a flat anteroposterior exposure, is made. Without allowing the patient to move, the table is now raised to the upright position, the tube is centered exactly as before, maintaining the same tube distance. The grid and the cassette are again centered. The sand bags are placed on the patient's shoulders and this is done none too gently. He



Fig 1 Flat plate with an opaque catheter in right ureter. Also two large laminated stones in the left kidney with several small non laminated stones



Fig 2 Artist's drawing of the two large laminated kidney stones. The upper stone is shown in two views while the lower and smaller stone shows only the face

Monocytes 5 per cent
Cells counted, 100
Wassermann test negative

Urea nitrogen 24.75
Creatinine, 1.83

venereal infection denied, difficulty in starting and stopping the stream, stream starting in jerks with loss of parabolic curve. Nocturia from two to six times, with a day urination of from five to six times. Some hematuria. A history of catheterization for retention. History also shows the usual childhood diseases. The family history carried no significance in respect to this case.

Blood pressure, 152/110, temperature, 99.4 degrees, pulse, 60, respiration, 20. The head, neck, heart, and lungs were found essentially negative upon examination.

The abdomen revealed marked tenderness in the left upper quadrant. There was a palpable mass in this area which was quite firm and adhered fairly well to the contour of the left kidney. No evidence of rigidity. Extremities and reflexes were essentially negative.

A blood and urine examination revealed the following information:

Blood Analysis
Hemoglobin 85 per cent
Red blood cells 4,500,000
White blood cells 8,250
Polymorphonuclears 70 per cent
Lymphocytes (large and small) 25 per cent

Urine Analysis
Straw-colored
Specific gravity 1.020
Alkaline
Few red blood cells
Albumin 1+
Acetone negative
Diabetic negative

Five days after admittance the patient was cystoscoped. The right side showed a normal phenosulphonethalein, with a negative catheterized urine specimen. The left side showed no phenosulphonethalein function, there was some pus present, epithelial and red blood cells. The urine was scant, even to the extent of only an occasional drop. Two cultures showed a growth of *B. coli*. A No. 21 F cystoscope was passed, the bladder containing 15 ounces of muddy urine with numerous large shreds. The bladder mucosa revealed multiple areas of crusty formation, marked trabeculations with subacute inflammatory infection. Catheters passed into the right kidney with ease, while on the left side the catheter met obstruction at the uretero-pelvic junction. The left ureter was markedly inflamed.

Four days after cystoscopy the patient expired of bronchopneumonia and an impending uremia.

Roentgen examination following retrograde pyelography showed the right kidney and ureter to be within normal limits. The left kidney showed dye in the ureter only, which was moderately dilated. The left kidney was enlarged and showed two large laminated kidney stones. An intravenous pyelogram revealed no additional information.

The stones grossly were hard, fairly smooth, but angular, conforming to or molded to the cavity in the renal parenchyma and pelvis containing them. The stones were quite large.



Fig 5 Slight change in position of fifth lumbar body Separation four displacement of pubic bones

manner, less than 15 per cent showed evidence of abnormality The procedure described is not recommended as a routine procedure but as a special examination in special cases

is encouraged to relax, using only such muscles as are required to maintain the upright position. The second exposure is then made. This

This method is not intended to replace the usual examinations of the lumbosacral region from which a diagnosis of organic pathology is

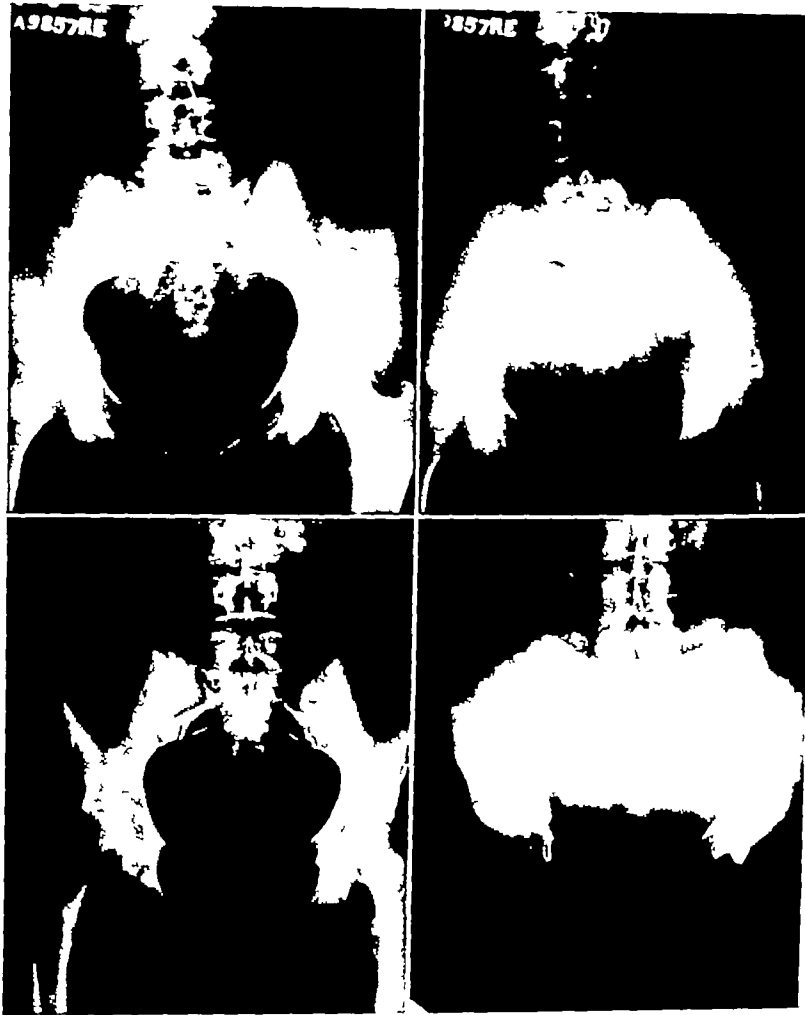


Fig 3
Figs 3 and 4 Changes in position of fifth lumbar body 5 mm downward displacement of sacrum

position requires a little longer exposure than the upright position does on account of an increase in the amount of soft tissue in and around the pelvis. In both positions, either anteroposterior or lateral exposures may be made, or both.

In the use of this technic four things must be done diligently: the tube distance must be constant, the relative positions of the tube, patient's pelvis, and the cassette must be constant, the compression band must be below the pelvis, and the patient must carry the weight of the sand bags. After processing, the films are viewed side by side or superimposed.

desired. It is not intended as an aid in the diagnosis of bone and joint disease, but it is intended as a functional diagnostic method. It applies particularly to some of those patients presenting lower back pain in whom roentgenograms, taken in the ordinary manner, show no organic pathology. Among the abnormalities already found by this method have been sacroiliac subluxations, marked change in the position of the fifth lumbar body, separation of the symphysis pubis, compression of the intervertebral disc between the fifth lumbar body and the sacrum, and ptosis of one or both kidneys. Of all the patients examined in this

COMMUNICATIONS

REPORT OF RADIOLOGICAL INTER-SOCIETY COMMITTEE

REMARKS BY THE EDITOR

The radiologists of this country no doubt will receive with the greatest interest and enthusiasm the report of the Radiological Inter-Society Committee

When the different radiological societies agreed to co-operate with the American College of Radiology in the formation of an Inter-Society Committee, they helped to create a movement which is of tremendous significance to each and every radiologist of this country. This committee, with its strong personnel, will at first make a survey of the professional and economic needs of radiologists all over America, and with the aid of their competent Executive Secretary, active work soon will be under way. We can look to the future with an optimistic attitude and appreciate that organized radiology will now be able to function most efficiently.

The report of the Inter-Society Committee, here appended, is in itself sufficient justification for its creation and existence. The members of the Committee certainly have undertaken their labors with honest zeal, and we wish them to know that we are willing and ready to serve them in any capacity they may wish.

REPORT OF COMMITTEE

The following is a report of the first meeting of the Radiological Inter-Society Committee, held at the Palmer House, Chicago, Illinois, Feb. 14, 15, and 16, 1937. All of the Committee were present.

Where there is no unity of action there will be a paucity of good results, whether the objective be the conquering of a nation or the diffusion of ideas. For some years the radiologists of America have sensed the need for unified action in order that the ideals of radiology might be realized, and our specialty might take its rightful place among the subdivisions of the practice of medicine.

Activated only by the realization that someone must take the first step, the Chancellors of the American College of Radiology, at their meeting in February, 1936, named a committee of three which, it was hoped, would be acceptable to all the radiological societies and might thus fairly represent all, or nearly all, American radiologists. At its Annual

Meeting in September, 1936, the American Roentgen Ray Society appointed the same committee to be its representative, and in December, 1936, the Radiological Society of North America took a like action. This movement having been endorsed in 1934 by the American Radium Society, the body of American radiologists found itself for the first time represented as a unity in its various national affairs and interests.

In November, 1936, the Julius Rosenwald Fund announced the gift of \$100,000 to the American Hospital Association to be used in the study and furtherance of group hospitalization plans. Since this is a subject in which radiologists are keenly interested, the Committee at once prepared a letter for transmission to the proper committee and the officers of the American Hospital Association. The Committee expressed deep interest in the various group hospitalization plans and the liveliest desire to co-operate with the American Hospital Association in their formation and development. The letter follows:

"In order to better co-ordinate the activities of the radiological societies of America, and to more clearly and authoritatively set forth the views of American radiologists, the national societies named above have constituted a joint committee to represent them in such matters as may be considered pertinent to the purposes for which the Committee was formed.

"This Committee, representing all of the national societies of radiologists, and thus practically all radiologists of America, notes the gift by the Julius Rosenwald Fund to be used for the furtherance and betterment of voluntary hospital service plans. Like all physicians, radiologists are interested in such plans, and are anxious to co-operate fully in their organization and operation. It is undoubtedly true that the majority of American families are poorly prepared to meet the sudden demands of severe illness, and constructive steps toward enabling such demands to be met should be encouraged and supported by all physicians and by their clientele. Not only as physicians, but as citizens, we have the strongest desire to co-operate in the study and furtherance of hospitalization plans, and anticipate the day when the hospitalization of all those who may come within their scope shall be under a hospitalization service plan, and it is our strongest desire to engage in

EDITORIAL

LEON J. MENVILLE, M.D., *Editor*

HOWARD P. DOUB, M.D., *Associate Editor*

LIFE INSURANCE AND THE RADIOLOGIST

A young radiologist recently applied to one of the larger insurance companies for a life insurance contract including waiver of premium disability and accidental death clauses. The life contract including the waiver of premium clause was issued without question but the applicant was informed that the accidental death clause could not be granted because of his "line of work." An investigation revealed that this same company issues life insurance contracts, including waiver of premium disability, disability income and accidental death clauses without restriction, to physicians, surgeons, and dentists who use x-ray machines in their practice. One would naturally presume that this discrimination against radiologists was based on experience data to justify it. When information concerning their experience with radiologists as insurance risks was requested it was admitted that there was not sufficient volume and the matter would be too heterogeneous to withstand analytical criticism. Information concerning the underwriting practice of six other large insurance companies revealed that with one exception all granted life insurance contracts including waiver of premium and accidental death clauses at standard rates to physicians and surgeons using x-rays incidentally in their practice. All of these companies consider the radiologist a standard risk for straight life insurance but only three allow the radiologist a waiver of premium clause at standard rates. Two companies will not allow a waiver of premium clause for the radiologist and another company charges a radiologist double the rate for this feature. In regard to the accidental death clause, three companies provide it at standard rates for a radiologist, one charges double the rate, another charges one and one-half times the standard rate, and a third will not allow this feature. Since one of the standard insurance handbooks lists 68 life insurance companies in this country, the above practices cannot be considered a fair average of the entire group. They do indicate, however, that as far as seven of the

largest companies are concerned, there is no consistent practice regarding the granting of waiver of premium and accidental death clauses to radiologists. It is doubtful if the experience of the companies represented can be so variable since the risk is relatively the same for each one. It is evident that most companies consider their experience tables confidential since no definite information concerning them could be secured. One of the largest companies stated that it had no experience on physicians and radiologists using x-ray and radium and as stated above, one company at least was frank enough to admit that its statistics were insufficient and too heterogeneous to withstand analytical criticism. Most life insurance companies now have discontinued writing disability income clauses. One company that still continues to do so will not grant this to a radiologist because of an unfavorable past experience. It is interesting to note in this regard, however, that two large companies specializing in health and accident insurance write disability income contracts for radiologists at standard rates, from which one infers that their experience with their risk has not been unusual.

There are some of us who believe that the specialist in radiology, who is trained in the use and care of his equipment, is a much better life insurance risk than the physician or surgeon who owns an x-ray machine and all too frequently uses it with only a superficial knowledge of its potentialities. I have reason to believe that this opinion is also shared by at least one medical advisor who has taken the trouble to study the radiologist as an insurance risk, and this is reflected in the rate schedule of that company. On behalf of the younger generation of radiologists for whom life insurance is an important asset, I bespeak a fair consideration of their risk by insurance underwriters, particularly on the part of large companies that should be in a position to compile accurate experience tables concerning the situation.

JOHN D. CAMP, M.D.

hereby approved by the Board of Trustees of the American Hospital Association

"1 The radiological service of the hospital shall be maintained primarily for the benefit of the sick

"2 Every hospital radiological department should be under the direction of a competent radiologist, preferably a diplomate of the American Board of Radiology¹ If, because of size or isolation, such arrangement be not feasible, some member of the general medical staff trained in radiology should be in charge and a consultation service arranged with a nearby radiologist

'3 *The radiologist is entitled to recognition as a professional member of the medical staff and as head of a hospital department*

"4 *The preservation of the unity of the hospital and its component departments and activities is an essential administrative principle This principle can be maintained without any infringement on professional rights or professional dignity*

"5 Inasmuch as no one basis of financial arrangement between a hospital and its radiologist would seem to be applicable or suitable in all instances, that basis should be followed which would best meet the local situation This may be on the basis of salary, commission, or privilege rental, but in no instance should either the hospital or the radiologist exploit the other or the patient

6 When an arrangement is effected whereby the radiologist of the hospital pays a rental for space and service, cares for non-pay patients and in return retains all private fees collected, such contract should clearly cover the matter of depreciation of equipment, replacements and additions, should protect the radiologist against excessive non-pay work and should take into consideration the 'good will by virtue of which a large proportion of the paying clientele is attracted

7 The American Hospital Association views with disapproval the proposal that the actual cost of films and associated overhead be separated from the professional charges of the radiologist or that the responsibility for this department be divorced from the hospital While in many instances this would be a financial relief to the hospitals, it would probably result in frequent omission of the radiological consultation with a specialist in radiology,

would mean less efficient radiological service with potential legal complications, and would tend to create difficulties with national and other organizations requiring supervision of the radiological work by a competent radiologist "

This Committee is happy to announce the engagement of Mr Mac F Cahal, of Wichita, Kansas, Executive Secretary of Sedgwick County Medical Society, as Executive Secretary Mr Cahal is a splendid type for the task which the Committee anticipates and has had several years of experience in this sort of work, having been for the past five years Executive Secretary to a large county medical association Mr Cahal will represent the interests of radiologists and of radiology at all times and in any place where his presence may be required The Committee considers this an enormous stride toward its ultimate goal and hopes and confidently expects the financial support of the various radiological societies

ANNOUNCEMENTS

THE NEXT ANNUAL MEETING OF THE RADIOLOGICAL SOCIETY OF NORTH AMERICA

Sept 13-17, 1937, there will be held in Chicago, at the Palmer House, the Fifth International Congress of Radiology, and the first to be held outside of Europe The Radiological Society of North America will hold its Annual Meeting during the same week as the Congress, and at the same place

The evening programs will be assigned to the national radiological organizations of North America Monday evening will be given to the American College of Radiology Their program will include the convocation and dinner, the international conference, etc This regular College function will start promptly at six o'clock and will be completed in time for the opening of the Congress at 8:30 on the same evening Tuesday evening will be given to the American Radium Society Their program will include the Janeway Lecture, dinner to foreign guests, special entertainment features,

¹ (In Canada this would read American Board of Radiology or an equivalent body)

friendly discussion with your committee concerning the exclusion of medical services and especially radiological practice from group hospitalization plans and contracts

"Simply stated, the questions which concern us most deeply are these. Shall radiology be included in voluntary hospital insurance plans? If this question is answered in the affirmative, then shall it be included as (a) a hospital service, or (b) as a medical service so closely allied to hospital service as to be inseparable in practice, but to be paid for by indemnification? If it can be established that hospital insurance plans are not feasible without the inclusion of radiology, then the answer to our first question *must* be in the affirmative and we must pass at once to the second question and bend all our efforts toward its satisfactory solution

"But can it be so established? It is essential that x-ray services be provided as part of hospital service, and will it be possible to devise satisfactory and workable plans for their inclusion? To these questions we are constrained to answer 'No'. No one disputes the thesis that radiology is a medical specialty, that it is a department of the practice of medicine, and that its practitioners are and must be physicians. This being true, then it is not difficult to see that if x-ray services are included in a hospital insurance plan, surgical, obstetrical, and urological service could be included with equal propriety. When such services *are included*, we will have taken irrevocable steps toward the complete socialization of both medicine and hospitalization, and compulsory health insurance will be upon us

"To argue (as has been done) that only the so-called 'technical services' will be included, is to state a thesis incapable of being successfully defended. No professional procedure can be divided into parts without the fatal wounding of that professional procedure. No one conversant with the problem can have any doubt but that such separation will result in two things: the ruin of a medical specialty, and increasingly poor practice within hospitals. Examples and arguments can be drawn at great length but are not necessary here. We will be glad to amplify any of these points to any degree if you deem it advisable.

"May we call your attention to the fact, known to you, of course, that the oldest and most successful of the plans now in operation,

namely, the Baylor (Dallas, Tex.) and Washington, D. C., plans, do not include and never have included x-ray services? The Memphis (Tenn.) plan has lately discontinued its x-ray benefits. The Alameda County (Cal.) plan furnishes x-ray and clinical pathology as a medical service, but does so by indemnifying its subscribers for the amounts expended by them. The Intercoast Society (California) has a like provision. It would seem, therefore, that it is possible to operate these plans without the inclusion of these medical services.

"May we not ask you, then, to consider carefully and to consult further with us, before making any recommendations which may not only destroy a medical specialty, but may lead to a lowering of hospital standards, to a lessening of the value of the service received by patients, and may even result in placing numerous hospitals in the unenviable position of violating the several Medical Practice Acts?

"We will welcome inquiry or further discussion, and beg the privilege of bringing you the opinions, reactions, and joint experience of the radiologists of this country.

Sincerely yours,

(Signed) ARTHUR C. CHRISTIE, M.D.
EDWARD H. SKINNER, M.D.
LOWELL S. GOIN, M.D."

Its letter was courteously received and a conference with representatives of the American Hospital Association was arranged in Chicago, at which conference the Committee was able to exchange views and to present the view point and ideals of radiologists. It is needless to say that had the Committee been unable to present itself as representative of all of the American societies and hence of all American radiologists, its efforts must have been much less effective.

Meeting with a larger group from the American Hospital Association an agreement as to the principles governing the relationship of hospitals and radiologist was reached. This agreement, which is a most happy solution to certain very vexing problems, states:

In view of the current discussions concerning the relationship of radiologists to hospitals and because of the desirability of protecting the public, of maintaining radiological services of high efficiency, and of safeguarding the hospitals, the hospital radiologist and the interests of the non-hospital radiologist, the following basic principles are

will not conflict with other activities of the Congress, namely, eight to nine in the morning

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THE PLACE OF IRRADIATION IN THE TREATMENT OF CARCINOMA OF THE UTERINE CORPUS
By LOUIS E PHANEUF, M D, of Boston

THE SELECTION OF FORM OF TREATMENT IN UTERINE MYOMIAS
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REVIEW OF THE CASES OF CANCER OF THE URETHRA AND VULVA
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JAMES G SPACKMAN, M D, of Wilmington, Del

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A DOSE CHART FOR INTERSTITIAL RADIUM ELEMENT NEEDLES
By LAWRENCE POMEROY, M D, of Cleveland, O

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ORGANIZATION OF TUMOR CLINIC IN GENERAL HOSPITAL WITH SMALL SUPPLY OF RADIUM
By JAMES S GALLO, M D, of Paterson, N J

MELANOMA-TYPES PATHOLOGY AND MANAGEMENT
By GEORGE T PACK, M D, and FRANK E ADAIR, M D, of New York City

TREATMENT OF EPITHELIOMAS OF THE NASOLABIAL FOLD
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By G ALLEN ROBINSON, M D, of New York City

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By IRA I KAPLAN, M D, New York City

THERAPEUTIC USES OF OESTRIN
By CHARLES F GESCHICKTER, M D, Baltimore, Md

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THE PROGRAM COMMITTEE
E H SKINNER, M D, *Chairman*
HAYES E MARTIN, M D
LYELL C KINNEY, M D

etc Wednesday evening will be given to the American Roentgen Ray Society Their program will include the Caldwell Lecture, banquet, entertainment features, etc Thursday evening will be given to the Radiological Society of North America Their program will include the Carman Lecture, banquet, special entertainment features, etc

In this way, the not inconsiderable advantages of participating in an International Congress will be easily available to all radiologists resident in the United States, Canada, and Mexico

EXCEPTIONAL EDUCATIONAL OPPORTUNITIES AT THE FIFTH INTERNATIONAL CONGRESS OF RADIOLOGY¹

(At the request of A C Christie, M D, of Washington, D C, President of the Congress, this announcement is repeated, with certain additions—*The Editor*)

An unusual opportunity will be offered at the Fifth International Congress of Radiology, Sept 13 to 17, 1937, Palmer House, Chicago, Illinois, for instruction in certain selected fields of radiology The courses to be offered are as follows

ROENTGEN THERAPY IN CANCER

Dr Henri Coutard, Chief of Roentgen Therapy Service in the Radium Institute, Paris, France

PROBLEMS IN ROENTGENOLOGICAL DIAGNOSIS

This is an advanced course for experienced radiologists which will deal with difficult problems of diagnosis selected from the vast material available at the Massachusetts General Hospital

Dr George W Holmes, Clinical Professor of Roentgenology, Harvard University Medical School, Director of Radiological Department, Massachusetts General Hospital, Boston, Massachusetts

¹Attention is directed to the addition of the course by *Dr Heyman* since the announcement of these courses in the March number of *RADIOLOGY*

Dr Holmes will be assisted by his associates, *Dr Aubrey O Hampton*, *Dr Richard Schatzki*, and *Dr Richard Dresser*

RADIATION THERAPY IN GYNECOLOGY

Dr James Heyman, Chief of the Department of Gynecology, Radiumhemmet, Stockholm, Sweden

THE FUNDAMENTALS OF ROENTGEN AND RADIUM THERAPY

Prof Dr Hermann Holthusen, Professor in the University, Chief of the Radiological Service, St George Hospital, Hamburg, Germany

ROENTGEN DIAGNOSIS IN GASTRO-ENTEROLOGY

Dr B R Kirklin, Professor of Radiology, University of Minnesota, Graduate School of Medicine, Chief of the Department of Radiology, Mayo Clinic, Rochester, Minnesota

Dr Kirklin will be assisted in this course by other radiologists who are outstanding in this special field

SPECIAL PROBLEMS OF RADIATION THERAPY RELATING PARTICULARLY TO TREATMENT OF CANCER OF THE CERVIX AND CANCER OF THE BREAST

This course is directed especially to the needs of the specialist in radiology and will be found of particular interest to radiologists located in the smaller centers of population

Dr Edwin A Merrill, Clinical Professor of Radiology, Georgetown University Medical School, Chief Radiologist, Warwick Memorial Clinic and Garfield Memorial Hospital, Washington, D C

THE DIAGNOSIS OF BRAIN LESIONS

Dr Merrill C Sosman, Assistant Professor of Roentgenology, Harvard University Medical School, Chief of Radiological Service, Peter Bent Brigham Hospital, Boston, Massachusetts

ELEMENTARY PHYSICS OF RADIATION

Dr James L Weatheruax, Philadelphia General Hospital, Philadelphia, Pennsylvania

Each of the above courses will occupy four hours, that is, one hour on each day of the Congress, September 14 to 17, inclusive. The courses will be given at an hour when they

will not conflict with other activities of the Congress, namely, eight to nine in the morning

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LYELL C KINNEY, M D



The late AUGUSTUS W CRANE M D

IN MEMORIAM

AUGUSTUS WARREN CRANE

1868-1937

radiology has suffered another great loss. Crane has gone to his reward. And surely it must be the eternal recompense for a life of such outstanding service to his fellow-men.

Few men in radiology have so importantly and favorably influenced a specialty. Due to the international distinction he won in his professional endeavor, Dr. Crane won a place in the highest esteem of his fellow-men for the personal characteristics which made him an extraordinary and kindly figure in his community, and which endeared him without exception to all with whom he came in contact.

Although he had already made a promising start in the general and laboratory practice of medicine, having published several researches relating to the physiology of the blood, the publication of Roentgen's discovery so fascinated young Crane that he devoted himself with untiring zeal to the study of the roentgen rays, their production, control, and application to the science of medical diagnosis and therapy. Within three months of Roentgen's first publication Dr. Crane had installed his first x-ray machine—a 12-inch coil operated by a homemade battery and mechanical breaker (March, 1897). His studies on the matter of interrupters, which, before the day of the interrupterless machine invented by H. C. Crook, by their eccentricities rivaled the gas ray tube in the botheration they caused the radiologist, were crystallized in a lecture at the University of Michigan in March, 1901, describing a method of operating a coil from an alternating circuit by means of an electrolytic interrupter. This lecture led to the general use of the Wehnelt interrupter for running x-ray coils on alternating current.

Dr. Crane's earliest and perhaps most noble contribution to the literature of radiology was a paper, illustrated by x-ray plates, read before the Kalamazoo Academy of Medicine on April 27, 1898, entitled "The Roentgen Ray in Diseases of the Lungs." Under the title "Microscopy of the Respiratory Organs," this paper was published in the "Philadelphia Medical Journal" of March, 1899. It was received so favorably in England that several medical authors incorporated large parts of it in

English text-books. It was real pioneer work, not sufficiently appreciated by many American workers. This essay was reprinted in the "American Journal of Roentgenology," 1916, Vol. 3, new series, p. 419, for the benefit of students of roentgenology who had not known of Dr. Crane's valuable early contribution. Readers of this page not familiar with this early pioneering of Dr. Crane will find it instructive to review what was so early accomplished by one man through the sheer force of his own initiative and his brilliant intellect. In this paper Crane really anticipated most of the radiological developments in the study of the chest during the next two decades.

In gastro-intestinal work Crane merits a pioneer's acclaim. His first plates of the stomach and colon were made on Dec. 8, 1905. In March of the following year he read a paper, illustrated with numerous plates, on "The Position and Shape of the Stomach and Intestines during Life." In June, 1907, there followed a paper on "Gastroptosis," and on Dec. 10, 1907, a paper on "Gastric Ulcer." This was also the title of his first paper before the American Roentgen Ray Society, in 1908. The following year he read before the American Medical Association on "X-ray Evidence in Gastric Cancer."

Dr. Crane's early training and interest in the study of the blood was continued in a paper read in 1907 on "Specific Immunity of X-ray Therapeutics," which called attention to the effect of the x-ray in producing an immunity parallel to that produced by vaccines.

In 1915 Dr. Crane read a paper before the American Medical Association entitled "Roentgenocardiograms," the term "roentgenocardiogram" being coined by Dr. Crane to conform with the term "electrocardiogram." This paper was pioneer work in a line of investigation now being brought to the fore under the name of "roentgenkymography."

Augustus Warren Crane was born in Adrian, Michigan, on Nov. 13, 1868, the son of Nathan Seeley and Julia Etta Chaffee Crane. After attending the Adrian High School and the literary department of the University of Michigan, he graduated from the medical department in 1894 as valedictorian of his class. He immediately afterward established himself in Kalamazoo, Michigan, in the general practice of medicine and surgery. Early attention was given to laboratory work, and in 1895 he was appointed city bacteriologist, the

first in the State of Michigan. His early medical papers before the Kalamazoo Academy of Medicine dealt with laboratory methods of diagnosis, pathology, and especially with various phases of blood examinations. In 1898 he made an effort to discover the biological meaning of the different blood cells by a study of the blood of mammals, reptiles, fishes, birds, worms, crustaceans, and insects, in the course of which he visited many scientific museums for the procurement of blood specimens. These researches were presented in a paper before the Michigan State Medical Society under the title, "Missing Links in the Clinical Examination of the Blood."

Until 1906 Dr. Crane carried on a large general practice and did considerable surgery, while continuing his radiological pioneering, but after that date he confined his practice to internal medicine, and after 1915 his work was restricted to diagnosis and consultation practice, in which roentgenology became his chief interest.

Crane maintained that the correlation of clinical data with the roentgen findings is the legitimate province of the clinical roentgenologist, and constitutes the main reason for the medical education of the roentgenologist. This is the reason, he maintained, why roentgenology is entitled to the recognition of a full professorship co-equal to the chair of medicine or surgery, why entitled to a separate section in the American Medical Association, why its worthy followers should be invested with all the privileges of professional consultation without discrimination from other specialties. Crane insisted that such a practice, while exclusively diagnostic except for roentgen therapy, is not exclusively roentgenological. He called it clinical roentgenology.

And so he may be considered to represent the ideal in a roentgenological specialist, a physician who all along maintained his standing and efficiency as a clinical diagnostician and practitioner of therapeutic radiology while developing superior skill in the application of the roentgen rays to medical problems.

Many honors have fallen to Dr. Crane. Early in his career he was made a member of the British Roentgen Society, 1899, president of the American Roentgen Ray Society in 1916, Caldwell Lecturer in 1932, acting editor of the "American Journal of Roentgenology" in 1917-1918, recipient of the gold medal of the Radiological Society of North America in

1921 for his achievements in the science of radiology, recipient of the honorary degree of Master of Arts from his alma mater in 1932.

At the time of his honorary degree from the University of Michigan, attention was called to the studied care which marked the written contributions of this pioneer investigator. Gifted with a facility of speech that is rarely the lot even of those whose vocation is to speak from the public platform, he was always able to interest and hold the attention of an audience. Possessed of a scientific imagination and a mastery in the use of metaphor, he was able to add interest to any subject on which he essayed to write. His papers were characterized by simplicity and clearness as well as by harmony in his choice of words. A Michigan editor recorded that as a phrase artist he was able to give pen to such expressions (referring to that part of the anatomy immediately above the diaphragm) as the "costal grill," "the thoracic cage," "the chest—that one cavity of the body ready-made for roentgen examination." He wrote of one radiologist as having "spent the best years of his life on a medical frontier." He wrote of roentgenology "The discovery was unexampled in dramatic surprise and promise." "The miracle of shadows cast by invisible light gave increasing power and precision to diagnosis." "It is the part of the pioneer to brave dangers and hardships. In this far region of the spectrum were lurking unknown dangers, unseen, insidious, deadly."

One of his latest contributions, "The Research Trail of the X-ray," presented at the American Congress of Radiology at Chicago in 1933, revealed the breadth of his investigations. This paper is a classic in radiological and scientific literature, and should be treasured by all whose interests center in radiology.

Dr. Crane's home life was a happy one. His wife was a distinguished minister of the Gospel and an important figure in state and national life. She preceded him in death by nearly two years. Surviving are two children, a daughter living at home, and a son, Warren Bartlett Crane, who will shortly graduate in medicine from the University of Chicago. Death came to Dr. Crane suddenly on the morning of Feb. 20, 1937, at the age of 68*.

JAMES T. CASE, M.D.

* The writer has borrowed freely from others in preparing this notice.—J. T. C.

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S M ATKINS M D , of Waterbury, Conn	E T LEDDY, M D , of Rochester, Minn
G E BURCH, M D , of New Orleans, La	ERNST A POHLE, M D , Ph D , of Madison, Wisc
JOSEPH DAUKSIS, M D , of Excelsior Springs, Mo	W A SODEMAN, M D , of New Orleans, La.
J E HABBE, M D , of Milwaukee, Wisc	WILLIAM R STECHER, M D , of Easton, Pa.
HANS W HEFKE M D , of Milwaukee, Wisc	CHARLES G SUTHERLAND, M B (Tor), of Rochester, Minn

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ABSCESS (PULMONARY)

The Treatment of Large Pulmonary Abscesses
Clarence E Bird Jour Am Med Assn Oct 17,
1936, 107, 1288-1292

In his series 65.7 per cent could not be ascribed to anything more definite than a "cold," "influenza," or "pneumonia." Of the others 28.6 per cent followed operations, infected traumatic wounds, or other extra-pulmonary infections.

The author stresses some 14 points that he considers to be of the greatest importance in relation to the surgical treatment of pulmonary abscess. Emphasis is placed on long continued dependent drainage, under hospital care, until the cavity of the abscess is entirely obliterated.

CHARLES G SUTHERLAND, M B (Tor)

ACTINOMYCOSIS

Roentgen Therapy of Actinomycosis J Martin-Crespo Strahlentherapie, 1936, 56, 650

In the author's opinion roentgen therapy is the method of choice in actinomycosis involving the face. He does not consider the internal administration of iodine as an essential part of the treatment. Technic: HVL Cu 0.98 mm, two convergent fields directed to the lesion 330 r each. This may be repeated if necessary after three weeks. While good results were obtained in the majority of the cases, the lock jaw in patients with processes of long standing was improved very little. Surgery should be limited to the draining of pus.

ERNST A POHLE, M D, Ph D

ANIMAL EXPERIMENTATION

Histological Studies of the Spleen in Rats Following Exposure to Graded Doses of Roentgen Rays E A Pohle and C H Bunting Strahlentherapie 1936 57, 121

The authors exposed the spleens of 181 rats to x rays (100 kv, 2.0 mm Al $\lambda_{\text{eff}} = 0.34 \text{ \AA}$). The doses varied from 5 to 5,000 r (measured in air) at intervals of from 0 minutes to 30 days. The animals were killed and the spleens prepared for histologic examination. The chief effects of roentgen rays upon the spleen were noted in the fixed and circulating blood cells in the organ; the lymphocytes appeared to be the most susceptible. Any measurable dose of roentgen rays (i.e. from 5 r up) produced injuries which are demonstrable microscopically. The earliest interval in which decisive lesions were found was 30 minutes. The histologic changes are well marked three hours after exposure. They are more marked at six hours and at 12 hours little evidence of injury is noted. At the 24 hour interval practically all cell detritus has been removed

from the Malpighian corpuscles. Spleens of animals treated with 100 r appear entirely normal when examined at 14- and 30-day intervals after the exposure. With doses of 1,000 r, 2,500 r, and 5,000 r, recovery of the Malpighian corpuscles appears complete in three days. In only one spleen (1,000 r) was fibrosis noted at the 30-day interval. No statement can be made as to late injuries, since the longest interval between exposure and microscopic study was 30 days.

ERNST A POHLE, M D, Ph D

The Radiosensitivity of the Cells of the Mammary Gland C W Turner and E T Gomez Am Jour Roentgenol and Rad Ther July, 1936, 36, 79-93

Experimenting with rabbits, the following conclusions were drawn. The rudimentary ducts of the breast of the young required considerable irradiation to depress the growth entirely, but less when they were first stimulated to growth by the estrogenic hormone.

When the duct system of the mature virgin rabbit was complete considerable irradiation was required to prevent lobule-alveolar growth, during pregnancy or pseudo-pregnancy the cells are very sensitive, and once effected remain so permanently.

S M ATKINS, M D

The Biologic Basis of the Newest Methods of Roentgen Therapy S R Frankel and I M Neumann Strahlentherapie, 1936, 57, 195

The authors studied the oxidation and glycolysis in normal tissue under the influence of roentgen rays in rabbits. Sixty-four animals were used divided into five series, one series served as control. The spleens of the animals were irradiated with single doses of from 600 to 1,800 r with fractional doses amounting to a total of 1,800 r in 12 days and the protracted fractional dose method with the same total dose (180 kv, 0.5 mm Cu + 1 mm Al, 23 cm FSD). The animals were killed by means of electric current and the tissues (taken from liver, spleen and kidneys) examined by the method of Warburg. Definite changes in the metabolism of these tissues as compared with the normal controls were detected. Histologic examination of the organs showed no changes in liver and kidneys while in the spleens of several animals, including the control series there was hemosiderin and some sclerosis. The relationship between the method of application and the type of changes observed is briefly discussed.

ERNST A POHLE, M D, Ph D

The Increase of Radioresistance Following Repeated Exposure to Small Doses of Roentgen Rays K Ferroux C Regaud and N Samsonow Strahlentherapie 1936 57, 12

Clinical observations seem to indicate that the radiosensitivity of previously irradiated tissue is lowered

The authors studied this problem experimentally by exposing the testicles of rats to roentgen rays. Technic 180 kv, 5 ma, 30 cm FSD, 8 mm Al + 15 mm wood, 75 r in 1 minute 15 seconds, the sterilization dose for the rat testicle amounted to approximately 1 180 r. 1 or a period of 10 months, 75 r were applied every month, then the full sterilization dose was given. Control rats received only the full sterilization dose. Within four months after its application no sperm cells could be found in the testicle, in only one animal out of seven a few were left. In the animals which had received the small doses over the ten month period before the application of the full sterilization dose the destructive effect was much less. The testicles of four out of five animals showed sperm cells in all stages of development, some looked entirely normal. It is concluded from these experiments that the exposure to the ten fractional doses reduced the radiosensitivity of the testicle. This is apparently the same phenomenon which has been observed in the treatment of malignant tumors.

ERNST A. POHL, M.D., Ph.D.

Studies of the Radiosensitivity of the Corpus Luteum and of the Uterine Membrane by Means of an Artificially Produced Decidua in the Rabbit. A. Lacasagne. *Strahlentherapie* 1930, 56, 621.

The ovaries and uterus of a number of small rabbits were exposed to roentgen rays (180 kv, 0.5 mm Cu + 30 mm Al, 5 ma, 35 cm FSD). The doses varied between 500 and 1 800 r. The animals were killed 12 days after exposure. It appeared that irradiation of the ovaries with large doses (1 300-1 800 r) given before the follicle rupture occurs, does not prevent the formation of the corpus luteum. The latter regresses early, which leads to a shrinking process in the uterine membrane. A less intense exposure (500-1 300 r) does not inhibit the normal development of the corpus luteum. The author concludes from his experiments that the uterine membrane is quite radioresistant.

ERNST A. POHL, M.D., Ph.D.

APPARATUS

The Practical Value of Double Exposure of Films. Ferdinando Taha. *Archivio di Radiologia* 1935 11, 365-378.

Taha illustrates the value that double exposures may have in x-ray examinations. In this technic all the factors of usual radiography are kept constant except the time of the first exposure which is reduced to one-half or one-third. The method may be of greater diagnostic help than the usual radiograph in studies of the bone or the ligaments of the abdominal viscera, the relationships of the various organs, the diagnosis of the site or the extent of some perivisceral process, the study of the mobility of foreign bodies especially in

the orbit and the localization of the depth of foreign bodies.

E. T. LEDDY, M.D.

An Automatic Roentgen Therapy Apparatus for Ultra Hard Rays. E. Pugno-Vanoni. *Strahlentherapie* 1930, 57, 338.

The author describes an apparatus for the production of ultra hard roentgen rays to be used in therapy. It can be operated at 800 kv although the tube at this time tolerates only 600 kv. It is constructed in such a manner that technicians may operate it and consequently it does not require the constant supervision of a physicist. A diagram of the circuit is appended.

ERNST A. POHL, M.D., Ph.D.

Special Problems in Ultra short Wave Therapy. J. Pützold. *Strahlentherapie* 1936, 57, 627.

The author pleads for more detailed data in publications dealing with short wave therapy. He believes that the type of apparatus, the wave length, the size of the electrodes and distance from the skin, the length of the cables, and the position of the patient should be stated. For determinations of the temperature he recommends a quartz benzol thermometer.

ERNST A. POHL, M.D., Ph.D.

ARTERIOGRAPHY

Surgical Treatment of Organic Obliteration of the Lower Extremities. Charles Mayer. *Bruxelles méd.*, May 17 1936, 16, 1090-1098.

While discussing the treatment of organic arterial obstruction of the lower extremities by resection of the second and third lumbar ganglia in seven cases the author details a radiographic differential diagnosis following injection of uroselectan into the femoral artery.

The author observes that following arteriography, in 36.2 per cent of 120 persons there was distinct amelioration of the pain and in some cases ability to return to work.

JOSEPH DAUSKYS, M.D.

ARTHRITIS

Treatment of Atrophic Arthritis. W. Paul Holbrook and Donald F. Hill. *Jour. Am. Med. Assn.* July 4 1936 107, 34-38.

Atrophic arthritis is a constitutional disease which manifests itself as a profound systemic disturbance and by a chronic deforming polyarthritis. It is a disease without a known single specific etiologic agent and likewise there is no single specific cure.

The authors review the therapeutic procedures from two angles the constitutional and the local. Diet should be arranged according to the patient's individual needs. The various problems of bowel management, removal of foci of infection, the use of vaccines, fever therapy, foreign protein injections, blood transfusions, and various medicines are discussed. General physical therapy can be carried out successfully only under the direction of a thoroughly trained personnel. The prevention and correction of deformity must anticipate the possibility of residual deformity in involved joints and avoid it. With proper and continuous care from the onset of the disease, there should be few deformities requiring special treatment.

CHARLES G. SUTHERLAND, M.B. (Tor.)

Roentgenological Changes in Chronic Arthritis. A Correlation with Clinical Observation for Long Periods of Time. S. L. Morrison and J. G. Kuhns. *Am Jour Roentgenol and Rad Ther*, 1936, 35, 645-655.

This study was made to determine what changes would be found in chronic arthritis in serial roentgenograms taken over long periods of time, and whether or not the clinical and roentgenologic changes paralleled each other. It was found that the roentgenologic changes are extremely varied at different ages of the individual, and at different stages of the disease, and a diagnosis of the type and severity should be made only after a review of all the data obtained from a study of the patient.

Roentgenograms determine the location, extent and progression of the disease, yet extensive changes may be compatible with good function. The morbid changes observed in roentgenograms usually progressed for a long time, no matter what the clinical course or treatment and became stationary long after clinical quiescence.

Recalcification occurred but rarely, fusion of the sacro-iliac joints was common. In older individuals the changes are more rapid. Both atrophic and hypertrophic manifestations were frequently superimposed as age increased.

S. M. ATKINS, M.D.

"Le Pied en Lorgnette" in Chronic Polyarthritis. M. Kartagener. *Schweiz med Wchnschr*, May 16, 1936, 66, 479-481.

The condition under consideration is that of massive resorption of the bone of the phalanges, the fingers then becoming too short for the superfluous skin which wrinkles and telescopes upon itself. This is a rare condition particularly when occurring in the toes. In the author's case the accompanying roentgenograms delineate the profound generalized osteoporosis of the involved digits and distal ends of metatarsals. The cause was unquestionably a resultant of polyarthritis.

WILLIAM R. STIEGLER, M.D.

BIOLOGIC EFFECTS OF RADIATION

The Summation of the Effect of Various Types of Rays on the Biologic Object. A. Liechti and J. H. Müller. *Strahlentherapie*, 1936, 57, 284.

The authors studied the summation of the effect of x-rays, Grenz rays and ultra-violet rays on *Ascaris* eggs and bacteria. Roentgen rays produced at 160 kv and filtered through 3 mm Al were used (H.V.L. ca 0.35 mm, 60 r per minute at 30 cm for the experiments on *Ascaris* and 100 r per minute at 23 cm for the bacteria). Technique for Grenz rays: 12 kv, 10 ma, 11.5 cm distance, 215 r per minute. The ultra-violet rays came from a quartz mercury vapor lamp. It was calibrated in arbitrary units by means of a photoelectric cell. From the experiments the authors deduce that there is incomplete summation of the effects of roentgen, Grenz rays, and ultra-violet rays. They assume, therefore, that the mechanism of effect of ultra-violet rays is quite different from that of roentgen and Grenz rays.

ERNST A. POHLE, M.D., Ph.D.

Genetic Experiments with Very Soft Roentgen Ray on *Drosophila melanogaster*. E. Wilhelmy, N. W. Timofeeff-Ressovsky, and K. G. Zimmer. *Strahlentherapie*, 1936, 57, 521.

After a brief description of the apparatus used by the authors to produce very soft roentgen rays at from 2 to 7 kv, they report the results of their experiments on the fruit fly. If the plasma is irradiated alone (without the chromosomes), no mutations are produced. The same holds true if the soma but not the gametes are irradiated. No difference in the rate of mutation could be noticed for radiation applied at 270 r/mm and 2,700 r/min. No effect of the wave length could be noticed for equal doses of radiation produced at 6.2 kv and harder radiation.

ERNST A. POHLE, M.D., Ph.D.

Specific Effect of Ultra short Wave Field. E. Schliephake. *Strahlentherapie*, 1936, 57, 151.

The author defines as specific effect of ultra-short waves such changes as cannot be produced by any other therapeutic agent in the same manner. Experimental and clinical observations are quoted which indicate that there is a definite relation between wave length and biologic effect.

ERNST A. POHLE, M.D., Ph.D.

THE BLADDER

Treatment of Cancer of the Bladder by Divided Doses of Roentgen Rays at Long Distances. R. S. Ferguson. *Am Jour Roentgenol and Rad Ther*, July 1936, 36, 73-78.

This is a report of a series of 48 cases, 36 of which

were verified by biopsy and observed cystoscopically. The first of these patients was treated in June, 1935, and thus the follow up is one year for the earliest cases.

The rate of primary regression exceeds that observed in any other form of irradiation. Twenty cases showed complete regression, with appearance of a new tumor in but one.

The roentgen prescription was 200 kv, Thoracur filter, 100 cm distance 100 r daily to each of two opposite portals till from 3,000 to 4,000 r had been given through four fields.

S M ATKINS, M D

BLOOD CHANGES

The Influence of Roentgen Rays on the Cholesterol Content of Blood and Serum in Women with Carcinoma or Sarcoma P H Schumacher and Dr Rusch *Strahlentherapie* 1936, 57, 532

The authors determined the cholesterol content of blood and serum in 40 women 25 of whom were suffering from carcinoma or sarcoma. Following roentgen irradiation no definite fluctuations of the cholesterol count in either blood or serum could be noted. There was no relation in this series between cholesterol content and roentgen sickness. No difference could be detected in the cholesterol fluctuations between patients with and without malignant disease. In all cases the cholesterol content of the blood seemed to be slightly higher than that in serum. The authors cannot recommend, therefore application of cholesterol by mouth as a preventive of x ray sickness.

FRANK A POHL, M D, Ph D

BONE DISEASES

Brodie's Abscess of Radius Due to Typhoid William B Marbury and Henry L Peckham *Jour Am Med Assn* Oct 17 1936 107, 1284-1286

Typhoid of the bones is one of the unusual types of inflammatory bone disease. Osteomyelitis complicating typhoid is not at all common. The ribs are the most common bones involved the tibia second and the spine third.

In bone disease following typhoid the symptoms usually come on so late that the typhoid bacillus is seldom considered as the etiologic factor, the interval may be from five to fourteen years. The authors report a case in which the interval was ten years.

Roentgenographically the lesion was a Brodie's abscess, a bone cavity filled with serum or pus lined by a fibrous membrane with surrounding sclerosed bone and a tendency toward obliteration of the adjacent medullary cavity.

Surgical intervention revealed pus which on culture proved to be the result of typhoid bacilli.

The prognosis is good if adequate drainage is supplied.

CHARLES G SUTHERLAND, M B (Tor)

The Bone Marrow, R H Jaffe *Jour Am Med Assn*, July 11, 1936 107, 124-129

The importance of the examination of the bone marrow *in vivo* becomes evident if one considers the fact that the circulating blood does not always reflect the condition of the bone marrow. Great differences exist sometimes between the cellular content of the blood and that of the bone marrow which may be the source of diagnostic errors. A brief discussion of the normal bone marrow is presented, with the changes that are observed in some of the important disturbances of blood formation. These include the anemias, polycythemia vera, agranulocytosis, the leukemias, thrombocytopenic purpura, hemophilia, tumors of the bone marrow, and bone marrow biopsy.

CHARLES G SUTHERLAND, M B (Tor)

The Causes of Traumatic Myositis Ossificans Following Dislocations of the Elbow Lorenz Böhler *Fortschr a d Geb d Röntgenstrahlen* June 1936, 53, 823-840

This is an important paper by this well known orthopedic surgeon. It reviews 124 cases of injury to the elbow, treated and re-examined repeatedly during the last ten years. Of these cases, 65 were recent injuries which came for reduction and treatment to Dr Böhler's clinic. An additional 24 were referred for treatment immediately after reduction, while 35 cases were referred after reduction and treatment for examination and medical testimony concerning their disability. For classification these patients were grouped as follows: (A) Pure and simple dislocations; (B) Dislocations with detachment of bony segments; (C) Combinations of fractures and dislocations; (D) Pathologic dislocations.

The paper then analyzes in detail 29 cases of Group A. 26 of these cases showed no sign of post traumatic myositis ossificans, only three showed a minimal degree of such abnormal bone formation. Functional results obtained were very satisfactory, as 27 of 28 patients had complete function of their elbows, while one case showed limitation of extension of 5 degrees. None of these patients complained of any distress and all showed normal power of their extremities.

As this result is quite at variance with others reported extensively in the literature and reviewed in this paper the author comes to the following conclusions. Traumatic myositis ossificans following dislocation of the elbow cannot be attributed to the primary trauma of the dislocation nor to the secondary trauma of the reduction as long as no over-extension was used. It must be attributed to the consequences of the after-care particularly early physiotherapeutic management, massage and forced passive motion. If following reduction the injured cartilages and the torn joint capsule ligaments and muscles are thoroughly immobilized for three weeks (preferably and most safely by a plaster cast) then all injured parts regenerate to such a satisfactory degree that circulatory or nutritional disturbances never occur such as lead

to permanent limitation of function or to myositis ossificans, traumatic arthritis, and osseous atrophy. Such unpleasant after effects, however, are caused frequently by additional injurious irritations.

The author gives the following rules for treatment of dislocations of the elbow:

1 Each dislocation of the elbow must be reduced at the earliest possible time through a suitable, carefully guarded procedure—no hyperextension!

2 The dislocated bones have to be immobilized following reduction for a time sufficient to permit of healing of the torn ligaments and other soft tissue tears (average, three weeks).

3 During this time of immobilization of the reduced articulation the other joints of the injured extremity and of the entire body should be moved actively, with avoidance of pain so as to prevent disturbances in circulation, atrophy of muscles and bones and stiffening of joints.

4 After removal of the plaster cast neither massage nor passive motion ever is used. Instead, gradually increasing active use is encouraged as long as it does not produce pain. Each injured individual is instructed not to permit anybody else to touch the injured extremity, in particular, to apply massage or passive motion.

The paper is illustrated by a large number of excellent reproductions of roentgenograms.

H A JARRE, M D

Contribution to the Symptomatology of *Ostitis condensans ossis iliei*. R Goedel. *Fortschr a d Geb d Röntgenstrahlen* September 1936 54, 256-258.

One case of this relatively rare disease was first described by Barsony and Polgar in 1928. This patient was under observation during seven years and while the typical appearance of the condensing osteitis of both iliac bones adjacent to the sacro iliac synchondrosis was observed three weeks after the onset of complaints, the progress of demonstrable changes was found to be extremely slow so that undoubtedly the disease had already existed for several years before first being observed. In contrast to the frequency noted by Hungarian authors the affliction undoubtedly is very rare in Vienna. It should not be confused with chronic sacro-iliac arthritis and probably results from a multitude of etiologic factors.

H A JARRE, M D

Etiology and Pathogenesis of Solitary Bone Cysts. W Weber. *Fortschr a d Geb d Röntgenstrahlen* June 1936 53, 501-506.

This paper represents an inaugural dissertation written under the guidance of Prof Dr A v Albertini, of Zurich, Switzerland. It contains a report of five cases of solitary bone cyst and leads to a review of the present conception of such cavities. Excluded from consideration are parasitic cysts, generalized skeletal disease like osteodystrophia fibrosa generalisata,

osteomalacia, rickets, scurvy, senile osteoporosis, deforming arthritis, Paget's disease, true bone tumor with central destruction, callus-cyst, cavity formation in bones which can be related to displaced epithelial anlage, bone abscess and cavity formation in cases of periostitis aluminosa, and finally encapsulated cavities following chronic osteomyelitis.

Four of the cysts reported were found in patients between 11 and 20 years of age, the last represents a typical post traumatic hematoma-cyst in the corticalis and was found in a man 29 years of age.

In three of the cases reported a cyst was well formed at the time a trauma took place and a pathologic fracture occurred. In none of the five cases was there any residual evidence of a previous possibly resorbed giant-cell tumor. The view that bone cysts should be correlated to preceding trauma is declined. The conception of von Mikulicz is supported, assuming that solitary bone cysts represent congenital developmental disturbances or post-natal disturbances in growing bones. The assumption of Geschickter and Copeland is cited in support of von Mikulicz's theory. (It appears to the reviewer however, that these two American authors would not be in conformity with the author in regard to the etiology of solitary bone cysts.)

H A JARRE, M D

Bone Changes in Chronic Fluorine Intoxication. A Roentgenographic Study. Paul A Bishop. *Am Jour Roentgenol and Rad Ther*, May, 1936, 35, 577-585.

Due to disturbance of natural distribution of the more concentrated forms of fluorine in minerals and agricultural activities the hazard of chronic intoxication from the ingestion of fluorine salts is increasing. Inhalation of these salts or fluorine gas appears to produce no ill effects.

The most evident general symptoms of chronic fluorine intoxication are loss of weight, impairment of growth in young individuals, loss of appetite, and cachexia. Mottled discoloration and pitting of tooth enamel occur during the period when the enamel is being laid down on the permanent teeth in regions where fluorine is present in the water. No effect is produced on teeth that are already permanent. The damage done outlasts the exposure and recovery is never complete.

Most of the fluorine salts are soluble and eliminated but some combine with calcium forming an insoluble salt which is deposited in the bones permanently. Low calcium intake hastens the onset and development of symptoms, while a liberal calcium intake tends to offset these effects.

Roentgenologic changes in the case reported by the author and the group of I Lemming Møller and Gudjonsson are as follows: increase in bone density without alteration of normal bone structure, lack of normal sharpness of the bone outlines and extension of calcification into ligamentous attachments. When the involvement is great the density is so homogeneously marked as to obliterate the bone detail.

The earliest changes appear in the vertebra and pelvis and as the disease progresses it extends to the periphery until even the bones of the hands feet and skull are involved. Normal osseous architecture is preserved and there are no destructive changes in the trabeculae. The indistinct margins of the bones are the result of extension of calcification into the soft tissue at the attachment of ligaments and muscles and thus in the spine, spurring and even complete bridging between vertebra may occur and produce stiffness. The intervertebral and articular cartilages are not involved.

This condition is benign and must be differentiated from metastatic carcinoma.

S M ATKINS, M D

BONE DISEASES (THERAPY)

The Treatment of Primary Malignant Changes of the Bone by Radical Resection with Bone Graft Replacement. Fred H. Albee. Jour. Am. Med. Assn., Nov. 21 1936 107, 1693-1698.

The author presents 13 cases in which radical resection of a tumor in a bone was carried out, this being followed by a plastic bone graft replacement.

In a number of selected cases at least it was possible to free the patient from a malignant condition of the bone and to preserve a useful extremity.

After everything has been said, the most important lesson to be derived from these 13 cases over a period of 17 years is that there has been no local recurrence of the tumor. From this point of view the procedure has proved as safe as amputation.

CHARLES G. SUTHERLAND, M B (Tor.)

BREAST CANCER

The Fate of the Patients with Carcinoma of the Breast Treated at the Roentgen Institute in Zurich during 1920-1932. E. Ganz. Strahlentherapie 1936 57, 413.

During the period of 1920-1932, a total of 344 patients with carcinoma of the breast were treated at the author's clinic, 342 were females and two were males. One hundred eighteen cases were operated on and had post-operative irradiation. The three year survival figures were 56 ± 4.5 per cent, the five year figures 40 ± 5.4 per cent, the 10 year figures 18 ± 6.8 per cent. In the group with pre-operative irradiation plus post-operative irradiation the available number of patients is still too small from which to draw any definite conclusions. Those treated palliatively because of the advanced state of the disease received some benefit. Out of a total of 65 cases, 4 ± 2.4 per cent were alive after three years, 4 ± 2.7 per cent lived after five years, and no patient reached the 10 year period. One hundred thirty-three patients with metastases were irradiated. 21 ± 3.5 per cent lived three years, $10 \pm$

2.7 per cent lived five years, and 2 ± 1.4 per cent lived 10 years. It was rather striking to note at what late stage of the disease the majority of patients presented themselves for treatment. Technic of treatment: 1 or post-operative irradiation, one supraclavicular and one anterior breast axillary area receive 360 r. The dose is repeated after eight days, after three weeks, and then at intervals of three weeks, one two and three months (150 kv, 3 ma, 3 mm Al 40 cm FSD for breast and axilla, 170 kv, 3 ma, 0.5 mm Cu 30 cm FSD for the supraclavicular area). For pre and post-operative irradiation, daily doses of 200 r up to total doses of 4000 r are given through two tangential areas before operation (180 kv, 3 ma, Thoraeus filter 40 cm FSD). Seven weeks after this treatment operation is performed. Post-operative irradiation is given according to the technic outlined above. For the palliative group, daily doses of from 180 to 240 r up to total doses of 7000 r are applied over two tangential areas. The technic is the same as for pre-operative irradiation. The metastatic lesions receive 300 r five or six times per field (180 kv, 3 ma, 1 mm Cu 30-40 cm FSD). Involved glands are treated with the same technic by giving 200 r daily up to 4000 r total dose. Based on a total number of 3,599 cases operated on only, the five-year cure amounted to 31.2 ± 0.7 per cent. The respective figure for 2044 patients treated by operation plus irradiation is 40.9 ± 1.09 per cent. Mathematical analysis shows that this corresponds to a minimum of 6 per cent (theoretical calculation) or 16 per cent (empirical calculation) in favor of the combined method.

ERNST A. POHLE, M D, Ph D

Roentgen Therapy of Primary Carcinoma of the Breast and the Doses Used Expressed in International Roentgens. J. H. D. Webster. Strahlentherapie 1936 57, 175.

The author outlines the dosage for several techniques which may be used in roentgen therapy of carcinoma of the breast. For details of the r values, the reader is referred to the original article.

ERNST A. POHLE, M D, Ph D

Lung Changes Subsequent to Irradiation in Cancer of the Breast. Elwood Emerson Downs. Am Jour Roentgenol and Rad Ther July 1936 36, 61-64.

From a study based on 70 necropsies among which were 53 cases that had received irradiation to the chest with intensities varying from the low to the high and 1 mm Al filter to 2 mm of copper and to as much as 10,000 r, it was concluded that fibrotic changes in normal lungs subsequent to irradiation are infrequent. Either of two distinct reactions may occur.

(1) A pleuropulmonitis, an edematous reaction which is transient usually disappearing within a year if the lungs are otherwise normal. In this reaction a foggy density is seen, usually extending from the hilus to the periphery. At times it is patchy and pleural.

involvement may be present. This may occur in from two to eight weeks after completion of a series of intensive treatments, but more commonly following a second or third series of less intensity.

(2) A fibrosis, which is permanent but rarely occurs unless the lungs are previously made vulnerable by metastasis, chronic disease or infection.

S M ATKINS, M D

Sterilization in Carcinoma of the Breast E Gerard Smith *Am Jour Roentgenol and Rad Ther*, July, 1936, 36, 65-72

Based on 12 patients of their own, whom they report in detail, and the review of the literature, the author believes that all women with carcinoma of the breast who have not reached the menopause should receive a sterilizing dose to the ovaries.

In certain cases marked improvement follows, as evidenced by disappearance of metastatic nodules in the skin, shrinkage of metastatic glands, improvement of blood picture, sclerosing of lytic changes in bone, alleviation of pain, and improvement of general health.

Life does not appear to be prolonged by this sterilization though the course is less painful, nor can conclusions be drawn as to the effect of the time interval of appearance of metastases.

The roentgen prescription was as follows: 200 kv, 4 to 20 ma, 0.5 mm Cu plus 4 mm celluloid filter, 50 cm distance anterior and posterior pelvis through 20×20 or 15×15 cm fields given in daily doses of 200 to 300 r till 600 to 1200 r were administered both anteriorly and posteriorly.

S M ATKINS M D

CALCIFICATION

Generalized Tuberculous Lymphadenopathy G Battigelli *Fortschr a d Geb d Röntgenstrahlen* July, 1935 52, 53-64

A report of several cases of widespread lymphadenopathy, with clinical and roentgenologic observations, the disease terminating in healing with unusually extensive calcifications. There is a review of the literature especially the Italian.

H A JARRE M D

Ossification of the Stylohyoid Ligament A Beutel *Röntgenpraxis*, October 1935 7 665-670

Two cases of ossification of the stylohyoid ligament are reported and the clinical importance of such anomalies is pointed out. In one case the left stylohyoid ligament consisted of a chain of bony tissue extending from the base of the skull to the cornu of the hyoid bone. On the right side there was only an abnormally long styloid process.

In the second case a very long left styloid process was found together with a long cornu of the hyoid bone

formed by ossification of the stylohyoid ligament and calcification in the hyothyroid ligament.

HANS W HEFKE, M D

CANCER (DIAGNOSIS)

The Transformation of Gastric Ulcer into Gastric Carcinoma J William Hinton and Max Trubek *Surg, Gynec and Obst*, January, 1937, 64, 16-21

The authors reviewed 118 cases of gastric carcinoma with the idea of studying the question of the transformation of gastric ulcer into gastric carcinoma. McCarty considered 68 per cent of gastric ulcers precancerous lesions. Wilensky and Thalheimer reported an incidence of from 1 to 2 per cent of gastric carcinoma in patients with gastric ulcers.

The average duration of symptoms in the authors' group of gastric carcinoma was 45.3 weeks. On the other hand, in a group of 104 gastric ulcers also reviewed by the authors the ulcer symptomatology averaged 4.5 years.

Of the 118 cases reviewed 38 patients were submitted to operation and in 11 of these a resection was done. Twenty-three patients of the 38 died following operation. Of the group of 80, 32 patients who were not operated on died in the medical wards. In 12 of these cases an autopsy was performed.

In the group of 104 cases of gastric ulcers, there were nine cases in which there was an element of doubt as to a gastric malignancy. In six of these patients, inflammatory lesions were found at operation. One patient refused operation, and in the remaining two cases evidence of carcinoma was found. In each of these two cases the clinical diagnosis was carcinoma but the roentgen ray findings were considered those of gastric ulcer.

The authors conclude that in their two groups of ulcer and of carcinoma they have failed to find evidence of the transformation of a gastric ulcer to gastric carcinoma in a single case. However, they believe it is possible that in some cases it is difficult to differentiate between a benign ulcer and an early ulcerating carcinoma. These questionable cases which make up only from 6 to 7 per cent of the total, should be resected.

J N ABE, M D

CANCER (THERAPY)

The Principles Governing the Radiation Therapy of Cancer George T Pack *Am Jour Roentgenol and Rad Ther*, August, 1936, 36, 233-244

In each case of malignancy in which radiation is to be employed an attempt should be made to determine in the beginning whether to try for cure or only palliation. Tumors of embryonal origin are for the most part radiosensitive, but there are exceptions in adult testicular teratoma and some mixed cell tumors. Again cellular rapidly growing undifferentiated tumors with

numerous mitoses should be responsive yet neurosarcoma and melanoma are notoriously resistant

In principle all radiation is either external (either x rays or radium) intracavitary, or interstitial (radium only)

The tissue dose within the tumor usually expressed in threshold erythema, is the smallest amount of radiation absorbed by any part of the tumor. The cancericidal dose for certain malignant tumors has been fairly well determined. For example intra-ovular squamous-cell carcinomas require 6 to 8 T.E.D. while transitional cell carcinomas and lympho-epitheliomas require only 2 to 4 T.E.D. Some radiosensitive mammary carcinomas will also disappear under relatively small doses but resistant breast cancers require as much as 10 T.L.D.

It has recently been estimated that x rays resulting when a potential of 1 500 000 volts is available will approach the quality (or shortness of wave length) of gamma rays of radium. However even were such x rays widely available they would not render obsolete the use of radium, the latter being essential for intra-cavitary and interstitial radiation.

The effective wave length of x rays depends upon the factors of potential and the atomic weight of the target, however only the former is varied in practical usage.

There is still some difference of opinion as to the significance of wave length in influencing tissue reactions. The only difference in electrons from very high voltage and low voltage x rays is one of speed but this difference in speed has an influence on the number of ions produced in the tissues per unit length of the path and the difference in concentration of the ions may alter the rate of recombination of ions and thereby influence the chemical changes on which radiation effects presumably depend finally. The sequence of events in the tumor cell appears to be (a) ionization, (b) chemical changes and (c) biologic effects.

There is good evidence both experimental and clinical to show that due to greater recuperation powers of normal tissues, low intensity and prolonged time of irradiation (within certain limits) will have greater differential destructive effect on tumor cells than on normal cells. This principle has been carried still further by a few workers who are using weak intensity roentgen rays from 8 to 12 hours per day over a period of weeks (Heublein method).

J. E. HADDE, M.D.

Experiments Regarding the Treatment of Skin Cancer with Very Soft Roentgen Rays. E. Ebbehoj. *Strahlentherapie* 1936, 57, 661.

The author treated superficial carcinoma of the skin with roentgen rays produced at 12 and 25 kv. Doses of 20,000 r applied in one sitting destroyed carcinoma of 1 mm depth. It healed with a barely visible scar. For 25 kv the dose amounted to 5 600 r and was applied to cancers of a depth of from 2 to 3 mm. Illustrations of patients before and after treatment are appended.

ERNST A. POHLE, M.D., Ph.D.

The Radiological Treatment of Cancer, 1929-1934. IV—Carcinoma of the Lips. G. E. Richards. *Canadian Med. Assn. Jour.* November 1936 35, 41-502.

The author studied the treatment of oral malignancy by roentgenology and surgery. This paper considers malignancy of the lip consisting of 334 cases of carcinoma and one case of sarcoma. Only previously treated cases were used. Of the total ten were females and six were lesions of the upper lip. The ages ranged from 20 to 95 years. The lesions were classified according to the size of the primary lesion and the extent of cervical lymphatic involvement.

The treatment of the primary localized lesions exclusively by radiological methods including the employment of such methods resulted in the disappearance of the lesions without recurrence in 96.5 per cent of the cases. The results became increasingly less successful as the size of the lesion and glandular involvement increased. The cosmetic results following radiological methods were excellent.

The surgical aspect of the problem is to be reported in the future.

Richards could find no convincing evidence that external irradiation of the neck as commonly practiced for prophylactic purposes can either prevent the development of glandular secondaries or control the once established.

G. E. BURCH, M.D.

The Treatment of Cancer of the Cervix Uteri at the Rhode Island Hospital. Herman C. Pitts and George B. Waterman. *Surg. Gynec. and Obst.*, January 1936 64, 30-38.

The authors described their technique of radium therapy of cervical carcinoma and report a series of 293 cases observed during the period from 1921 to 1931.

In the period from 1921 through 1925 the author employed a total dose of from 3 000 to 4 000 milligrams in two or three treatments two or three weeks apart. Two 50-milligram tubes filtered by silver and brass in tandem in a rubber tube was used in the cervical canal. One 50 milligram and two 25-milligram tubes and 10 steel needles of 5 milligrams each were either made into a pack and placed against the cervix or in many cases the radium needles were employed interstitially.

In 1926 the plan of treatment was modified and four 3 milligram, 0.5 mm platinum needles of 45 mm active length were placed into the tissues at the sides of the uterus two on each side. From twelve to sixteen 2 milligram 0.5 mm platinum needles of 30 mm active length were placed in the tissues at from 1 to 2 cm intervals in front and back of the cervix. A 20-milligram platinum capsule or the tandem of the two 50-milligram tubes are used in the cervical canal. From 1926 through 1928 the radium was left in place from 72 to 96 hours. In 1929 this time was increased to from 144 to 168 hours.

Of the 293 cases of carcinoma of the cervix examined 17 were too advanced to treat or refused treatment. The absolute survival rate under the older method of treatment was 20 per cent and under the newer method 31.7 per cent. The absolute survival rate for the period from 1921 through 1930 was 26.9 per cent. The uncorrected immediate mortality for the entire group was 2.9 per cent. The incidence of fistula under the older method was 9.1 per cent and under the newer method, 6.3 per cent.

J. N. ANE, M.D.

Results of Radiation Therapy of Carcinoma of the Bronchus. H. Engels. *Strahlentherapie* 1936, 37, 445.

During 1926-1933 92 patients with carcinoma of the bronchus were treated in the University Institute for Radiation Therapy in Frankfurt on Main. The entire treatment was extended over a period of from four to five weeks. From four to six areas were applied with total doses of from 6,000 to 12,000 r. Of the patients, 7.6 per cent remained free from recurrences for a period longer than three years. While this number is still small it demonstrates beyond doubt that carcinoma of the bronchus can be successfully treated by irradiation. A number of illustrative case reports are appended and roentgenograms made before and after treatment shown.

ERNST A. POHLE, M.D., Ph.D.

The Treatment of Rectal Carcinoma by Surgical Freeing and Exposure to Close Roentgen Therapy. H. Chaoul. *München med. Wchnschr.* June 12, 1936, 83, 972-974.

Theoretic considerations are elaborated upon proving the distinct advantages of this new method. In brief the technique consists in a preliminary two-stage operation of colostomy and freeing of involved bowel by resection of the cecum and a portion of the sacrum. The colon is incised the length of the bowel through the infiltrated area permitting direct application of the roentgen tube under visual control. A biopsy is always obtained at this time. Five to ten days subsequently, roentgen therapy is instituted which consists in irradiating through numerous fields, no larger than 25 sq. cm. each and irradiation of the entire neoplasm even though there be overlapping of fields. This is of no serious importance, mainly because physical experimentation shows a marked falling off of the amount of irradiation at the periphery of the fields which is explained on the basis of obliquity of rays at the periphery passing through a relatively thicker filter.

In Chaoul's experience rectal carcinoma is but slightly radiosensitive and a total dosage of from 10,000 to 15,000 r per field is necessary. The surgical freeing of the neoplastic site aids in irradiating the site of lymphatic drainage which is situated chiefly behind the rectum. Following this intensive irradiation, necrotic areas intermingled with purplish granulations appear which are used as criteria for cessation of treatment. Unfortunately, many times these areas are difficult to dif-

ferentiate from malignant tissue. If after from two to three months the carcinomatous involvement is completely eradicated, or even if necrotic areas are well circumscribed, the natural bowel passageway is reconstructed after excision of the involved bowel segment. In nine cases of far advanced extensive inoperable carcinoma of the rectum, six showed complete disappearance of the tumor. In a single case recurrent areas necessitated further irradiation. It is notable that two cases were of two years' duration clinically and after efficacious treatment the patients gained weight and were able to return to their former occupations. In the failures, one case was very far advanced and incompletely mobilized beside, the other case presented resistant recurrences.

In reviewing the German literature, the author estimated that an average of 13 per cent had a five-year survival period, obtained by surgical measures alone. He makes a strong plea for continued trial of this combined surgical radiologic method, and he feels confident that far better results will thereby be attained.

WILLIAM R. STECHER, M.D.

The Influence of Electromagnetic Waves on the Freund-Kaminer Cancer Reaction. G. Fuchs. *Strahlentherapie* 1936, 57, 636.

Freund and Kaminer developed a serum reaction called "cytolytic" and protective reaction for the detection of carcinoma. The author studied the effect of roentgen irradiation on the course of the reaction. He found that the serum of a cancer patient would act more like normal serum after exposure to roentgen rays. Following the treatment of cancer serum with short and ultra-short electric waves it reacted like a normal serum. Long electric waves did not seem to have any effect.

ERNST A. POHLE, M.D., Ph.D.

Roentgen Therapy of Carcinoma and Periodicity of the Epithelial Changes. H. Coutard. *Strahlentherapie* 1936, 56, 577.

The English reader will find the essentials of this article published in the *Proceedings of the Institute of Medicine of Chicago* Oct. 15, 1935 Vol. 10, No. 16.

ERNST A. POHLE, M.D., Ph.D.

Roentgen Therapy of Malignant Papilloma and Carcinoma of the Bladder. C. Gil y Gil. *Strahlentherapie* 1936, 57, 32.

After a brief review of some recent publications regarding end results in the treatment of carcinoma of the bladder, the author analyzes 28 cases which came under his own observation. He used the fractional dose method as practised by Holfelder. 180 kv., HVL in Cu 0.95 mm., 26 r/min. at 30 cm. FSD, 4-5 fields, surface dose per area 1,500 r. total dose in the depth 2,800 to 3,300 r. The duration of treatment varied from 12 to 21 days. Of the 28 treated cases, 39 per cent were still alive after three years. They were distributed as follows: five out of five malignant papil-

lomas, five out of nine superficial carcinomas and one out of 14 advanced carcinomas

The author concludes that electrocoagulated and recurrent papilloma of the bladder can be cured by roentgen therapy. Prophylactic irradiation following electrocoagulation is valuable. The superficial neoplasms are also susceptible to roentgen therapy while the more advanced type is quite radioresistant.

ERNST A. POHLE M.D., Ph.D.

THE CECUM

Inversion of the Cecum Its Relationship to Appendicitis. Ferdinando Talia and Demetrio Constantino. *Archivio di Radiologia*, March-April 1936, 14, 91-107.

Talia and Constantino report the results of a study of 992 patients who had a lesion in the ileo-cecal region and found that in 11 per cent there was external rotation of the cecum and in 0.3 per cent internal

E. T. LEDDA M.D.

THE COLON

Secondary Resections in Recurring Carcinoma of the Colon. J. W. Thompson. *Jour. Am. Med. Assn.*, Nov. 21, 1936, 107, 1688-1692.

Carcinoma of the colon is a very common lesion, which occurs at all ages. In approximately 50 per cent of all cases encountered the disease has advanced beyond hope of surgical relief. There is an operative mortality varying from 5 to 35 per cent. Frequently the recovery of the patient is stormy, and in lesions of the rectum and lower part of the colon there is all too often the mutilation and social isolation associated with permanent colostomy. In growths more proximally situated, the problem of colostomy is avoided but the frequency of recurrence is greater. Metastasis to the liver and to regional lymphatic channels is always a specter which haunts the life of the individual fortunate enough to survive operation. The outlook for a patient proved to have even an operable carcinoma of the colon is to say the most not greatly encouraging.

In lesions of the colon in which there is not definite evidence of metastasis in the liver recurrence in or about the site of previous operative intervention should not deter one from re-exploration with a second attempt at removal of the neoplasm.

A small series of such cases is presented.

Multiple malignant lesions of the colon are probably not so rare as commonly believed. They may occur simultaneously or develop after a period of many years.

CHARLES G. SUTHERLAND M.B. (Tor.)

Multiple Polyposis of Colon. Familial Factor and Malignant Tendency. Descum C. McKenney. *Jour. Am. Med. Assn.*, Dec. 5, 1936, 107, 1871-1876.

Erdmann and Morris divide this lesion into two classes: the first the acquired or adult type; the

result of some form of irritation; the second, the adolescent (congenital disseminated type) characterized by familial tendency and probably in some cases at least, congenital. The author considers only the adolescent type. Five cases were selected for group study but in only two was it possible to get in contact with relatives in sufficient number to warrant a report.

Two facts were pretty well established—this disease does have an hereditary tendency, and if these individuals live a normal span of life a malignant growth will develop in the majority of them.

CHARLES G. SUTHERLAND M.B. (Tor.)

Diverticulitis of the Sigmoid Colon. Roscoe R. Graham. *Canadian Med. Assn. Jour.*, January 1937, 36, 1-7.

Graham points out that the limitation of x-ray in the diagnosis of diverticulitis of the sigmoid colon is no reflection on the radiologist nor on the method of examination. The clinician and radiologist must accept an equal responsibility in arriving at a diagnosis. X-ray examination in 30 patients studied resulted in 17 (57 per cent) correct diagnoses. Contrast barium enema proved one of the most useful techniques in aiding the diagnosis. The variation of the x-ray defects in cases of diverticulitis and the mimicry in cases of malignancy render impossible in some instances the accurate differentiation of an inflammatory from a neoplastic lesion. Difficulty was also encountered in the ability to assess the progress of the local lesion solely by comparative x-ray studies taken over a period of months. Graham concludes that the responsibility of the diagnosis of the exact nature and progress of this lesion should be shared by the radiologist and the clinician, with the latter holding himself responsible for the final decision.

W. A. SODEMAN M.D.

CONTRAST MEDIA

Fatal Iododerma Following Injection of Iodized Oil for Pulmonary Diagnosis. D. W. Goldstein. *Jour. Am. Med. Assn.*, May 9, 1936, 106, 1659-1660.

Reviewing the literature Goldstein failed to find a report of death following the injection of iodized oil into the lung. He presents the case of a male aged 47 years who was admitted to the hospital with an eruption that was more or less limited to the face and upper extremities. Two days before 20 c.c. of lipiodol (Lafay) had been injected into the lung for diagnostic purposes. The following morning a papulopustular eruption was noted over the forehead and face which gradually spread to the upper part of the chest and the extensor surface of the arms and hands. The temperature rose to 101.4° F. The patient became nauseated and finally was brought to the hospital in a stupor. The result, no doubt of a severe toxemia. The urine tests were repeatedly positive for the presence of iodine. The diagnosis was iododerma and acute glomerulone

phritis The lesions gradually spread over most of the body The nephritis became more marked and the patient died twenty-six days after the onset of his illness, of nephritis, plus an overwhelming toxemia.

The author considered it conceivable that in a markedly sensitive or allergic individual a sufficient quantity of iodine could have been absorbed to be responsible for the eruption

CHARLES G SUTHERLAND M B (Tor)

THE CRANIUM

Lesions Involving the Cranium and its Contents
Charles G Sutherland Am Jour Med Sci, November, 1936, 192, 735-744

The author very briefly reviews the use of roentgenology in the diagnosis of lesions involving the cranium and its contents The review considers the developments of the past two to three years, using the most significant advancements of the more remote past to link present roentgenologic practices

G E BURCH M D

DERMOID CYST

A Roentgenologic Criterion of Dermoid Cyst Dallas
B Phemister, William B Steen and John C Volder-aer Am Jour Roentgenol and Rad Ther, July, 1936 36, 14-18

A new sign in the diagnosis is presented namely a fluid level that shifts with the position of the patient This is due to the fat which is present being liquid at body temperature Absence of this sign is not dependable negative evidence since presumably some dermoids will not contain a suitable mixture of non-lipoid and lipid material A case is presented

S M ATKINS M D

DIABETES

Hypertension and Diabetes Their Treatment by Radiotherapy James H Hutton. Am Jour Roentgenol and Rad Ther June, 1936 35, 813-817

During an interval of a little over two years 157 cases of hypertension have been treated with small doses of radiation over the pituitary and adrenal glands Of these, 97 were improved 24 unimproved and 37 either insufficiently treated or not followed During the same interval, 18 cases of essential hypertension and diabetes were similarly treated of which seven were improved as to both conditions four as to hypertension only and three as to diabetes only and three were insufficiently treated or not followed Of 45 cases of diabetes without hypertension treated, 20 improved, 12 did not improve and 13 were insufficiently treated or not followed

The technic is 120 kv p, 10 X 10 cm portals over each side of the head and 15 X 15 cm portal for the two adrenals, 50 cm distance, 76 roentgens Treatments are given at weekly intervals, or at longer intervals if the blood pressure begins to fall, a series consisting of six treatments each of the above fields

J E HABBE M D

Roentgen Irradiation through the Temples for Diabetes Mellitus Corrado Montefusco Archivio di Radiologia 1935, 11, 397-403

The author in the three cases he studied was unable to demonstrate a definite change in the elimination of water the chloride or the carbonate balance after bitemporal irradiation There was a slight lowering of the glyceic level and a slight elevation of the cloremic level

E T LEDDY, M D

DOSAGE

Variations in the Technic and Biologic Effects of Fractionated Doses of X radiation H E Martin Strahlentherapie, 1936 57, 73

The author says that 'the protracted dose principle therapy has opened up entirely new vistas in the treatment of malignant tumors The possibilities of this method have not been exhausted by its application to pharyngeal tumors, nor by the use of x radiation alone Except in the relatively easy problems of radiation therapy, such as the treatment of small cancers of the skin it seems probable that the protracted dose principle will prove to be generally preferable to the massive dose method If in certain anatomic locations, interstitial or intracavitary radium is preferable to x rays the protracted dose method may still be advantageous A partisan attitude toward any one method of therapy, whether it be toward surgery x rays, or radium, may, in certain instances be productive of rapid developments from the purely scientific standpoint, but on the whole, we believe that cancer therapy and the interests of the cancer patient are best served by a fair minded and intelligent application of variations and combinations of all methods, in most cases'

ERNEST A POHLE, M D, Ph D

The Use of Roentgen Rays of Moderate Wave Length in the Treatment of Certain Diseases R Reynolds Strahlentherapie, 1936 57, 132

The author believes that there is a group of diseases which responds well—if not better—to roentgen rays of moderate penetration He feels that in view of the present tendency for higher voltages, this fact should be kept in mind A few examples are quoted in the paper In chronic mastitis a potential of 80-100 kv, no filter half a skin dose given three times at weekly intervals usually suffices In chronic myelogenous and lym-

phatic leukemia, irradiation may be started with 80-100 kv, 0.5 mm Al, one skin dose over two areas over the enlarged spleen. The same dose is given over the long bones. After from five to seven days the treatment may be repeated. In severe cases one half of the skin dose is sufficient. If the treatment has to be conducted over a longer period, 120-180 kv filtered through 3 mm Al or 0.5 mm Cu + 3 mm Al is the preferable technique. Lymphadenoma is treated with 90 to 100 kv filtered through 0.5 mm Al, and half a skin dose. In the author's experience the masses disappear often in from four to five days. Chronic tuberculous affections seem to respond well to one half to three quarters of a skin dose with potentials of from 120 to 160 kilovolts. This dose can be given once a week or even less frequently. Improvement may be expected in the course of two or three months.

ERNST A. POHLE, M.D., Ph.D.

Practical Experiences with the Reliability of Indirect Dosimetry. H. Holthusen. *Strahlentherapie* 1936, 57, 459.

The author describes the method of calibration of the x-ray apparatus for therapy in his institute. He measures the output in r (in air) and calculates the dose on the surface. This "indirect" method has proved reliable over a sufficient number of years to warrant its recommendation. Especially valve tube equipment has improved the constancy of output to render the method practical. The skin reactions observed after doses determined in this manner proved to be so similar as to offer a biologic test for its accuracy.

ERNST A. POHLE, M.D., Ph.D.

A Method for the Concentration of Roentgen Rays in the Depth. V. Maragliano. *Strahlentherapie* 1936, 57, 299.

In order to improve the depth dose of roentgen rays the author constructed an apparatus which converges the beam of the radiation. The device called a "concentrator of rays" consists of a thick block of paraffin resting on a lead filter which has an opening. A lead cylinder is attached which contains numerous small canals arranged in spiral shape. The entire cylinder is rotated by a motor. Due to this arrangement the emerging radiation is said to be homogeneous. A few sketches are appended illustrating the apparatus and its working mechanism.

ERNST A. POHLE, M.D., Ph.D.

Dosage of Gamma Rays by Ionization Measurements. G. W. C. Kaye and W. Binks. *Strahlentherapie* 1936, 57, 608.

At the last International Congress in 1934 the authors expressed the opinion that the "roentgen" can be used for determining the dose in radium therapy. They studied the problem further with 100 and 180 mg of radium respectively filtered through 0.5 mm Pt.

When using a well defined beam of radiation a large open air ionization chamber as well as a chamber with walls made of air equivalent material can be used. If scattering is avoided the air wall chambers are suitable for measurements in the beam without diaphragms. The measurements showed that the unit proposed by Sievert (1 mgh at 1 cm distance) corresponds to about 7.7 r.

ERNST A. POHLE, M.D., Ph.D.

Dosimetry in Radiation Therapy. I—Gamma ray Measurements in Roentgens. Otto Glasser and Leopold Rovner. *Am Jour Roentgenol and Rad Ther*, July, 1936, 36, 94-104.

Experimental studies of the standard air chamber during the past few years have shown it to be incapable, in its present form of measuring the true value of free air ionization produced by radiations of very short wave lengths.

These limitations of operating range do not seem to affect ionization measurements made with the small enclosed type of chamber when measurements are made in a large volume of irradiated air.

A series of studies of the adequate nature of air wall materials for enclosed chambers has been put forth by many authors and seems to find a useful unification of result in the measured values of the radium ionization constant $r/mg\text{-hr-cm}$ (roentgens per milligram element hour at 1 cm distance). The constant $r/mg\text{-hr-cm}$ can thus properly serve as a standard upon which to base the ionization measurements of ultra short wave radiations.

The authors have conducted further measurements on the value of $r/mg\text{-hr-cm}$ and have obtained results in general agreement with their earliest measurements and with the work of other authors. Their value of the air ionization constant for gamma radiations of Ra B and Ra C filtered by 0.5 mm Pt, is 8.8 $r/mg\text{-hr-cm}$.

S. M. ATKINS, M.D.

ENCEPHALOGRAPHY

Cerebral Roentgenoscopy as an Aid in Pneumoencephalography and Encephalography. A. J. Bendick and Ben H. Balser. *Am Jour Roentgenol and Rad Ther*, June 1936, 35, 790-794.

When injected with air the entire ventricular septum is readily visualized on the fluoroscopic screen. The authors make practical application of this fact in the making of ventriculograms and encephalograms by placing the patient into whose cerebrospinal system air has previously been injected into the optimum Trendelenburg and semi-erect angles under roentgenoscopic guidance for filming the ventricles.

J. E. HABBE, M.D.

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TECHNIC OF RADIUM TREATMENT OF CARCINOMA OF THE RECTUM¹

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THE technic of radium treatment of carcinoma of the rectum varies more widely than that employed for malignancy found elsewhere in the body. This is perfectly natural and comprehensible when one considers the special problems encountered and the peculiarities of rectal cancer as contrasted with cancer of other organs.

It is, of course, known that carcinoma of the rectum is insidious in onset, most patients consulting a physician about a year after the appearance of symptoms. While the majority of such cancers prove on microscopic examination to be of a low grade of malignancy, there is a marked tendency for them to metastasize to vital organs and the outcome in untreated cases is invariably fatal. A German authority recently studied a large series of untreated cases of rectal carcinoma and found that most patients survived only a year or two after the diagnosis was established, 90 per cent lived from one and a half to two years, 7 per cent lived three years, and only 1 per cent lived five years (1).

A majority of patients with rectal carcinoma are in the advanced age group and many have other chronic degenerative diseases. In such cases one is called on to treat an organ which must continue its duly function, and one must work in a

heavily infected field which cannot be sterilized.

SURGICAL CONSIDERATIONS

Carcinoma of the rectum presents a major surgical problem, and the radiologist must co-operate closely with the surgeon as well as with the proctologist. Careful study of each individual patient is necessary before a plan of treatment can be worked out. In well selected cases in which lesions are operable—and decision as to operability requires much study—pre-operative radium treatment offers a great deal (2). In cases of inoperable lesions, radium therapy secures palliation and increased length of life in comfort to many patients whose condition otherwise is hopeless.

Operability—Classification defining the lesion's extent or operability is a prerequisite to well planned therapy for malignancy anywhere in the body. In rectal carcinoma, however, many difficulties are presented. One must consider the size of the lesion, its location and accessibility, the general condition and age of the patient, the grade of malignancy of the tumor, the presence or absence of distant metastasis, and the degree of fixation. For instance, a small local growth in the case of a patient aged 77 years who has arteriosclerosis and myocardial changes would hardly be considered operable. Nor would a small movable lesion in the case of a patient in good

¹Read before the Radiological Society of North America at the Twenty-second Annual Meeting, at Cincinnati, Ohio, Nov. 30-Dec. 4, 1936.

general health which biopsy revealed to be of Grade 4 malignancy, because of the known tendency of lesions of a high grade of malignancy to metastasize widely and also to recur after excision

In our series of 132 cases the result of the original classification with regard to operability is only partially shown in Table I. While from the table it would appear that 60 per cent of the 132 patients had inoperable lesions when first seen, in reality the true percentage of inoperable cases was more than that because the data in the table were secured from the primary examination of the patient, and 15 patients, or 11 per cent of the total, were first referred for radium therapy in 1934, with recurrences from previous operations. In two of these cases prior operation had been performed in 1931, in one case in 1932, in eight cases in 1933, and in four cases in 1934. Hence, since the lesions in these cases, being recurrences, were therefore inoperable, these 15 cases must be subtracted from the total in figuring the original operable and borderline groupings (Table I).

TABLE I—LOCATION OF LESIONS AND INITIAL CLASSIFICATION AS TO OPERABILITY

Location	Cases	Per cent	Operable		Borderline		Inoperable	
			Cases	Per cent	Cases	Per cent	Cases	Per cent
Anorectal	20	15	6	30	3	15	11	55
Low rectal	30	30	12	30	0	—	27	70
Mid rectal	27	20	12	44	0	—	15	56
High rectal	26	20	4	15	4	15	18	70
Rectosigmoidal	20	15	8	40	3	15	9	45
Total	132	100	42	32	10	8	80	60

The location or accessibility of the lesions is of great importance from the standpoint of radium treatment. In Table I it will be seen that 30 per cent of the total growths were in the anorectal and rectosigmoidal regions, being about evenly divided between the two. Growths in these two regions present difficulties in treatment. Anorectal lesions are exquisitely painful and tender to any manipula-

tion. Many of these growths are squamous-cell epitheliomas. On radium treatment, these speedily undergo regression, affording marked palliation, but unfortunately metastasis to the inguinal lymph nodes is extremely common and the prognosis is, therefore, guarded. Rectosigmoidal tumors often extend upward, and since it is possible to treat only those growths which are visible through the endoscope, treatment is necessarily limited.

Biopsy—Biopsy has for many years been routinely performed at the first proctoscopic examination whenever this has been possible. We feel that the information so obtained is most valuable and that the risk, if any, is small. A small fragment of tissue about the size of a grain of wheat is removed with a rongeur. In this series of cases biopsy was positive for malignancy in 125 cases, or 95 per cent of the total. Of the remaining seven cases, biopsy was not made in four (in one of these cases surface healing had occurred from recent radium treatment elsewhere). In the other three cases inflammatory tissue was reported, however, in all three of them the growth was obviously malignant clinically, and evidently representative tissue had not been selected for examination. In Table II it will be noted that 86 per cent of all

TABLE II—RESULTS OF BIOPSY

Type of Cell	Grade of Malignancy				
	1	2	3	4	
Adenocarcinoma	29	54	4	4	
Adenocarcinoma in adenoma	8				
Papillary adeno- carcinoma	8	6			
Colloid carcinoma			3	2	
Squamous-cell epithelioma		2	4		
Fibrosarcoma		1			
Inflammatory tissue	3				
Biopsy not performed	4				
Total	7	45	63	11	6
		108		17	
		(86 per cent)		(14 per cent)	

positive biopsies revealed malignancy of Grades 1 and 2, and in only 14 per cent of

the 125 cases was malignancy of Grades 3 and 4

Colostomy—The value of colostomy in cases of carcinoma of the rectum presents an interesting problem. In this series colostomy was not performed in 75 cases, or 57 per cent, but was performed in the remaining 57 cases, in four instances elsewhere. There is no question but that colostomy is necessary when marked obstruction is present and the general condition of the patient permits. Beside relieving obstruction, the operation allows exploration of the viscera for evidence of metastasis, affording very valuable information which may alter the whole plan of treatment. In addition, the field of treatment can be kept much cleaner after colostomy, and a larger dosage of radium can be employed because ensuing stricture will not be so disturbing.

Patients with rectal carcinoma, however, can be cured without colostomy, and palliation has been secured in many other cases. The technic of treatment has to be more delicate in such cases, and the dose of radium milder to reduce subsequent stricture. The patient must be given a low residue or non-residue diet during treatment, with mild cathartics and daily rectal irrigations. Many patients with extensive inoperable lesions, if no serious obstruction exists, can be treated by dietary measures and colostomy can be postponed for a year or longer.

TYPES OF RADIUM TREATMENT

The technic of radium treatment for the various types of rectal lesions is difficult to describe. Binkley, for example, has stressed the importance of implantation and of telerradium. Careful summing up of the whole situation in each particular case, however, is a prerequisite to intelligent planning. The technic of radium treatment varies widely according to the purpose to be achieved. Methods fall into two general categories: (1) radical aggressive treatment intended to effect a possible cure, and (2) limited palliative treatment intended to relieve pain and to retard the progress of the growth when the lesion is

inoperable. The former plan is, of course, attended with some risk.

Radical Aggressive Treatment—In the first category is the careful insertion throughout the substance of the growth of needles containing radium element or gold radon seeds, employing sacral anesthesia, also, and with less risk, the precise application of two universal tubes, strapped together with adhesive to form a small plaque, inserted through the endoscope directly against the growth.

Radical or aggressive radium treatment is indicated in two classes of operable cases: (1) as a pre-operative measure, best given while the patient is convalescing from colostomy (three months after this series of treatments the patient should return for consideration of radical resection), and (2) in cases of small polypoid lesions of a low grade of malignancy. In such cases the growth may be destroyed entirely, without subsequent surgical treatment, by fulguration (5) using monoterminial current (which destroys tissue by desiccation) and radium.

Limited Palliative Treatment—In the category of limited palliative treatment not engendering much risk is the application of radium packs at a distance. Single tubes heavily filtered with lead and rubber are placed through the proctoscope in the center of annular growths, and two or three universal tubes arranged in tandem in the center of a hard rubber applicator are inserted into the rectum for the treatment of anorectal or low rectal neoplasms. Vaginal applications are employed for women, using the vaginal portal as an additional focus for irradiation.

TECHNIC

Our technic of radium treatment at the Clinic has been undergoing modifications from time to time. In order to analyze the most recent methods, we have checked the records of all patients with carcinoma of the rectum who were for the first time referred for radium treatment to the Section on Therapeutic Radiology of The Mayo Clinic during 1934. Patients who returned during the year but who had pre-

viously been treated with radium were not included. This is in no sense, however, a study of results, the results of radium treatment having previously been published (3). As has been mentioned previously, there were 132 patients in all, 78 (or 59 per cent) being males, and 54 (or 41 per cent) being females. The youngest patient was 28 years of age, the oldest 86, the average age was 58, 75 per cent of the patients were more than fifty years of age.

Radical or Aggressive Radium Treatment Implantation—Gold radon seeds containing from 1 to 2 millicuries each, or needles containing 1 mg of radium sulphate filtered through platinum, were used in 10 of our 132 cases. Surgical diathermy with bituminal current (which destroys tissue by coagulation) was employed in two of these cases to facilitate introduction of the needles and to minimize bleeding and the spread of infection. In two additional cases of recurrent carcinomatous masses, 5 mg steel alloy needles were employed.

The technic of implantation consists, first, in careful preparation of the patient. A non-residue diet is necessary for several days if colostomy has not been performed. The rectum is carefully and thoroughly cleansed with soap and water enemas. Sacral block anesthesia is employed and a kidney rest position is used. The lesion is exposed with a proctoscope, and the field is carefully washed and cleansed with green soap and water and antiseptic solution. The needles or seeds are then distributed as evenly as possible, an effort being made to irradiate each cubic centimeter of tissue.

Contact Treatment—Contact treatment consists in the application of two universal tubes, containing equal amounts of radon or radium sulphate, strapped together side by side to form a small plaque. The two brass tubes are covered with rubber to avoid the effects of secondary irradiation. Long strings are then attached to this two-tube plaque. The patient, following rectal cleansing enemas and a hypodermic of "H M C No 2" or one-sixth grain (0.01 gm) of morphine sulphate to relax the

parts, is placed on the proctoscopic table and the lesion is visualized by endoscopic methods. The lesion is then cleansed with an antiseptic solution and the plaque is placed directly against the lesion. It is held in place by a liberal packing of gauze moistened with antiseptic, the packing is used distal and proximal to the radium plaque and displaces the opposite rectal wall. The dosage employed varies from 40 to 100 millicurie- or milligram-hours per square centimeter of malignant tissue surface covered by the plaque. The variation is determined by the extent of infiltration and the amount of packing which can be inserted to protect the opposite wall as well as by the size of the lumen and the presence of a colonic stoma, and so forth.

The patient rests quietly in bed after the plaque is in position, usually sleeping under the influence of the hypodermic medication. The area covered by the plaque measures about 2.5 by 1.5 cm, daily doses being continued until the entire surface of the lesion has been treated. The objection may be raised that radium tubes so applied will not remain in place. Very careful packing of gauze beyond and below the plaque, however, should retain it in position. When patients return after three months, examination reveals that changes in tissue due to treatment are well confined to the area of malignancy. We would like to emphasize the fact that this contact treatment demands as much care and concentration as interstitial treatment. The proctoscopes and metal packers employed are marked in centimeters to record the exact position of each application.

Contact treatment was employed in 89 of our 132 cases, in 27 cases treatment followed destruction of the growth by electrothermic methods. We have found it expedient to begin treatment at the time of fulguration—immediate treatment tends to prevent post-fulguration hemorrhage as well as to destroy residual cancer cells.

These various types of radical aggressive treatment, of course, entail some risk. The treatment planned had to be abandoned because of complications in only five

instances, and there were no hospital deaths in this group of cases

Limited or Palliative Radium Treatment—Limited or conservative treatment in the main entails very little or no risk. It was used in the majority of our cases for advanced inoperable lesions. In our series of 132 cases there was clinical evidence of metastasis to the liver in 13 cases, and metastasis was proved at colostomy or exploratory operation in nine of these cases. Metastasis to the lungs was present in four cases, and to the ribs in one. Metastatic supraclavicular nodes were found in one case. Metastasis to the aortic lymph nodes was found in one case, to the omentum in another, and to the mesentery in a third case, all proved at operation. In two cases the growth had perforated to the bladder, and in two other cases to the peritoneum.

Metastasis to the inguinal lymph nodes is very common, especially with cancers of the lower part of the rectum. These nodes were enlarged and shotty and suspicious of metastasis in 68 cases. For all of these desperately ill individuals only limited treatment, of course, could be advised.

Treatment of the 15 patients with recurrent carcinomatous lesions was for the most part palliative, in only two cases were radium needles inserted into the recurrent growth. In eight of these cases telerradium was employed, in the remaining five, radium tubes. It is interesting to note in this connection that a third of these recurrent lesions were of a high grade of malignancy (Grades 3 and 4). This is in contrast to 14 per cent which represents the percentage of lesions of these grades of malignancy in the series as a whole. The high mortality in cases of recurrence of rectal carcinoma is illustrated by the fact that only three of these 15 patients (20 per cent) were living two years after treatment for the recurrence, and only one of these patients appears to be free of the disease.

External Irradiation—Thirteen of the patients in the series received this form of treatment, which consisted of 200 mg of radium filtered through lead at a distance of 5 cm over several portals. Eighteen pa-

tients received high voltage roentgen therapy, seven having received such treatment elsewhere. The inguinal regions were externally irradiated by radium blocks in 68 cases, in the case of low rectal lesions the groins were treated almost routinely, especially when the nodes were enlarged and firm, or prominent in one groin and not the other. The groins were checker-boarded into areas 4 cm square, 50 mg of radium was then used, filtered with 2 mm of lead at a distance of one inch (2.5 cm) over each area. Four areas were treated at a time and an erythema dose was employed.

Central Irradiation—Forty-two patients with annular lesions were treated by central irradiation. One tube, with or without additional lead and rubber as a filter, was placed in the center of the involved intestinal lumen. A field corresponding to the length of the tube was treated daily. Lead was used as a filter when lesions were thick or much superficial necrosis existed. Dosages ranged from 300 to 700 millicurie-hours per application. The intention in such cases was to retard the growth and maintain a patent intestinal lumen.

Vaginal Irradiation—Forty-one of the 54 female patients received vaginal radium treatments in addition to irradiation of the intestinal malignancy, itself, 2 mm of lead and 1 cm of rubber were used as a filter.

Other Forms of Irradiation—Radium tubes consisting of 0.5 mm of silver and 1 mm of brass were used on a lead stem in four cases and inserted in malignant rectal sinuses, 300 to 400 millicurie-hours per field being employed. In 32 cases of anorectal or low rectal lesions, moderate irradiation was employed, using three tubes of 50 millicuries each in tandem in a hard rubber applicator. This treatment was used mainly for annular lesions, a total dosage of about 450 millicurie-hours being employed.

SUMMARY

Carcinoma of the rectum is a rapidly fatal disease attended by severe pain, bleeding, and intestinal obstruction. The

viously been treated with radium were not included. This is in no sense, however, a study of results, the results of radium treatment having previously been published (3). As has been mentioned previously, there were 132 patients in all, 78 (or 59 per cent) being males, and 54 (or 41 per cent) being females. The youngest patient was 28 years of age, the oldest 86, the average age was 58, 75 per cent of the patients were more than fifty years of age.

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PERORAL X-RADIATION IN THE TREATMENT OF INTRA-ORAL CANCER¹

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THE protracted, fractional, or divided dose principle of radiation is now widely accepted as being preferable to the massive dose method in the treatment of malignant tumors in general. The favorable results obtained by this principle of radiation in pharyngeal growths logically suggest its use for those of the oral cavity proper. Experience has shown, however, that intra-oral tumors are generally more radioresistant than those of the pharynx, and that interstitial as well as external radiation is required for their control in most cases. We are of the opinion that these two methods of radiation (external and interstitial) may be combined to advantage in the treatment of practically all intra-oral cancer. In this combination of meth-

Adequate dosage by any method for large or radioresistant tumors of the oral cavity is commonly attended by certain untoward effects, both immediate and remote, in the adjacent normal tissues, and the technic described in this report is designed so as to lessen the incidence and severity of these untoward effects.

One of the main objections to the use of divided dose x-radiation in the treatment of cancer of the oral cavity proper is that, if the skin of the cheeks and/or submaxillary regions is used as the portal of entry, undesirable reactions are produced in the overlying or adjacent normal tissues. The nature and form of these undesirable reactions may be defined as follows. First, there are the immediate and temporary

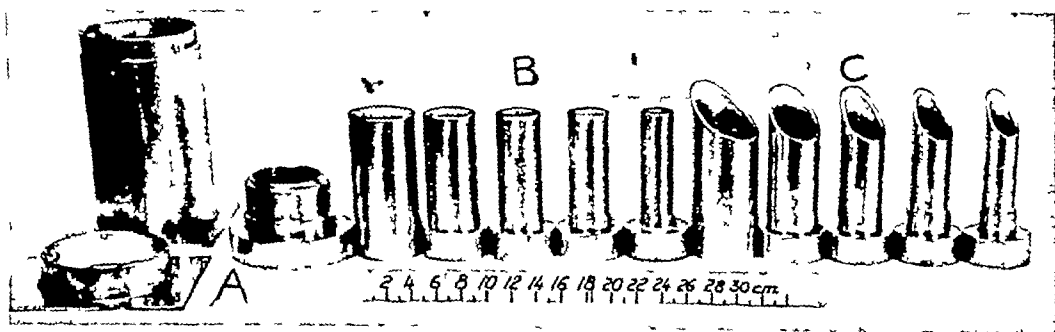


Fig 1 Interchangeable cylinders for peroral x-radiation. By combination with the master cylinders (A) and the interchangeable cylinders (B), target-skin distances of either 35 cm. or 50 cm. may be obtained. Interchangeable cylinders of the regular shape (B) have diameters of 5, 4, 3, 5, 3, and 2.5 cm., respectively, and are used when the direction of the beam is at right angles to the tumor surface. A corresponding set of cylinders with oblique-shaped ends (C) are used when the tumor must be approached obliquely.

ods, the external radiation is given first in daily divided doses over a period of from two to three weeks, and is then followed immediately by the implantation of a small or moderate dose of radon seeds.

effects which consist of an acute radiation dermatitis in the skin and a radiation mucositis in the normal tissues of the cheeks, jaws, palate, or tongue. If these reactions are not confined to the local tumor area, but extend widely, they are highly objectionable, since not only do they increase the discomfort, but also sorely tax the

¹ Read at the Twenty second Annual Meeting of the Radiological Society of North America in Cincinnati, Nov. 30-Dec. 4, 1936.

onset is insidious, and in most cases the condition is well advanced when patients are first seen. Surgery and radium therapy can co-operate in the cure of less extensive lesions and in other cases effect palliation.

A review of the 132 cases in this series of patients who were first referred for radium therapy at The Mayo Clinic during 1934 indicated that most of the patients were in the advanced age group, their average age being 58 years. Other degenerative diseases were present in many cases and the life expectancy was accordingly not high. In the majority of the cases the lesion was inoperable as a result of metastasis or of its extent and fixation.

Radical or aggressive radium therapy was employed in 12 cases and consisted of interstitial treatment with radon seeds or radium element needles, with or without the aid of surgical diathermy. This treatment was also used as a pre-operative measure, radical excision of the growth being carried out later. Contact treatment consisted of two tubes strapped together to form a plaque, which was maintained securely against the lesion by rectal packing. This treatment was employed in 89 cases. Daily treatments were given until the entire surface of the lesion was irradiated. Another method of attack in the case of small lesions was destruction of the growth by fulguration followed immediately by this contact method of treatment. Such patients should be re-examined every three months and further treatment given if necessary.

Conservative or limited treatment was applied in the remaining 31 cases in this series. In these, the lesion was advanced and inoperable, and palliation was all that was intended. The technic consisted of external irradiation with either radium at

a distance or roentgen rays. Teleradium was employed over the lymph nodes of the groins. Heavily filtered tubes were placed in the center of annular growths, and additional vaginal applications were employed for female patients.

CONCLUSIONS

Radium is a very flexible agent and treatment can be applied in a variety of ways. Each patient must be studied carefully and the intent of treatment definitely established, that is, whether cure is possible or only palliation can be expected. The technic differs for the two groups. In the smaller group showing possibility of cure, especially close co-operation with surgery is indicated. Colostomy is optional but very valuable.

The treatment of carcinoma of the rectum presents obstacles not encountered in dealing with malignant neoplasms of other organs. Treatment is necessarily tedious and involves extreme care and concentration. Patients cannot be treated hurriedly, nor can treatment be standardized. The reward of good results varies directly with the care and judgment exercised and with experience in treating this intractable condition.

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to the desired area and volume, and to insure its correct direction to the tumor. We have constructed such metal cylinders of brass tubing (lined with lead) in various sizes (2.5, 3, 3.5, and 4 cm in diameter)

terior nasopharynx or antra, since these regions must be approached obliquely through the open mouth.

The patient may be placed in the dorsal recumbent position on a table and the tube-



Fig 2 C (above) Fig 2 E (below)

Fig 2 D (above) Fig 2 F (below)



Fig 2 Peroral x radiation with the patient A in a recumbent position and B C D, E and F seated in a chair, the tube-holder tilted and adjusted. The position of the head is maintained by a head rest.

The jaws can seldom be separated to admit larger diameters than 4 cm. All of these fit into a master cylinder or cone so as to be readily interchangeable. The various shapes and sizes are illustrated in Figure 1. The regular shape (Fig 1-B) is used for lesions of the cheeks, anterior portion of the tongue, floor of mouth, etc. Those with the tapered oblique-shaped ends (Fig 1-C) are used for the tonsillar or palatal regions where the projecting edge may serve as a tongue depressor. The tapered end is also advantageous in irradiating the pos-

holder lowered so that the cylinder enters the mouth at the proper angle (Fig 2-A). Although this method may be somewhat unwieldy, it has the advantage of stability once the proper set-up has been achieved. A more flexible technic is to place the patient in a sitting position before the tube-holder, which is then tilted, raised, or lowered, and the position of the patient's head adjusted until the desired set-up is obtained. The position of the head is maintained by an adjustable head rest attached to the chair (Figs 2-C, 2-D, 2-E, 2-F).

local and general tolerance Secondly, there are the remote effects, such as late radionecrosis, osteomyelitis, or dental caries, which are due to diffuse degenerative changes in the soft tissues, the bones

discussion is concerned, that is, the elimination of the overlying or intervening layers of normal tissues by the use of the open mouth as the portal of entry in the external radiation of intra-oral tumors



Fig 2-1



Fig 2 B

of the jaws and in the dental apparatus Such complications, both immediate and remote, would undoubtedly be justifiable in an effort to cure an otherwise lethal disease if they were unavoidable, but we believe that they may be largely obviated by the technic which we shall describe in this report

One of the best methods of prevention is to employ the open mouth as the portal of entry so that a narrow beam of γ -radiation strikes the tumor area without first traversing an overlying layer of normal tissue If this is impossible, one may so locate the skin portal and so direct the beam of radiation that while it may pass through normal tissues before reaching the tumor, it avoids those normal structures most easily injured (bone and dental structures), both proximal and distal, to the tumor area It is with the first of these propositions that this

By using the open mouth as the portal of entry for γ -radiation, a growth of the tongue, tonsil, etc., may be converted into a surface tumor, so that it will receive the greatest intensity of any tissue in the incident beam of external radiation The conversion of intra-oral tumors into surface lesions for purposes of external radiation makes them somewhat resemble skin tumors, whose relative ease of control by radiation depends in great part on their position at the surface

Peroral γ -radiation is applicable for growths of the following regions the tongue, floor of mouth, jaws, mucosa of the cheeks, tonsils, hard and soft palate, maxillary antra, and posterior nasopharynx The base of the tongue and that portion of the pharynx below it require external skin portals, since they cannot be approached directly through the open mouth

TECHNIC

An essential factor in peroral x-radiation is the use of metal cylinders attached to the tube-holder which serve to separate the lips and jaws, to retract certain normal intra-oral structures in the approach to the tumor, to limit the beam of radiation

horizontal and the vertical plane is decided upon. These factors are then recorded in relation to fixed anatomic structures, such as the angle of the jaw, inner or outer canthus, pupil of the eye, lobule, tragus, or other portions of the ear, etc. By such means, the correctness and uniformity of all subsequent set-ups are assured. This diagram should be used for reference at each subsequent treatment. From a lateral position, the horizontal level is observed and adjusted, and then standing behind the patient, the position of the patient's head is adjusted in relation to the direction of the beam in the vertical plane.

drawn out of the mouth and positioned so that the growth may be made most directly accessible (Fig 2-E)

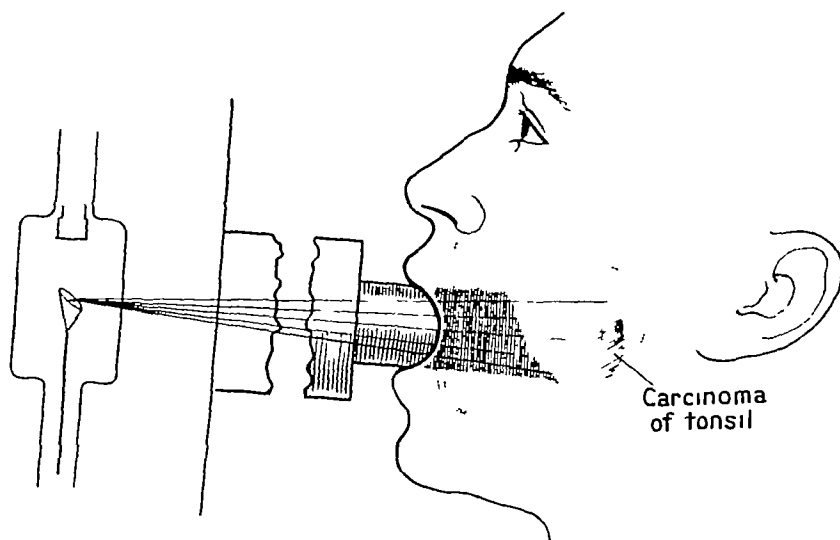


Fig 4 Diagrammatic representation of peroral x-radiation in cancer of the tonsil

Each individual case will require its own modifications and adjustments. The set-up for a tonsillar lesion is shown diagrammatically in Figure 4. For lesions of the mucosa of the cheeks, the cylinder and direction of the beam are almost transverse (Fig 2-B). For the anterior floor of the mouth or the anterior portion of the tongue, the beam is tilted obliquely downward and backward (Fig 2-C). For the posterior nasopharynx, it is tilted upward (Fig 2-D). In lesions of the lateral border of the tongue, the patient is directed to grasp the tip of the tongue with his fingers and by a combination of protrusion and traction to one side, the tongue is partly

DOSAGE

In the average case, the dosage is chosen with a view to the implantation of a supplementary dose of radon gold seeds, except in such locations as the posterior nasopharynx, where the peroral portal is combined with skin of the cheek portals or with a nasopharyngeal radium capsule.

The size of the total dose will depend on a number of factors, such as the size of the portal (cylinder), the position and histologic character of the growth, and the intended supplementary dose of seeds. In an average situation, such as a tumor 2.5 cm in diameter on the lateral border of the tongue, we would use a cylinder 3 cm in diameter, and apply a daily dose of from 200 to 250 r for 20 daily doses for a total of from 4,000 to 5,000 r, and immediately implant from 6 to 8 millicuries in seeds. For larger portals 4 cm in diameter in the same location, the dose is reduced to from 150 to 200 r daily for a total of from 3,000 to 4,000 r in the same period. Smaller portals 2.5 cm in diameter may be given from 350 to 400 r daily for totals of 6,000 r or more. The above mentioned doses are measured in air at the target-skin distance

We have treated a number of patients perorally with an x-ray tube structurally built in a fixed position with a fixed portal point-

In selecting cases for treatment by this technic, one should make certain that the growth is of suitable size and position to be

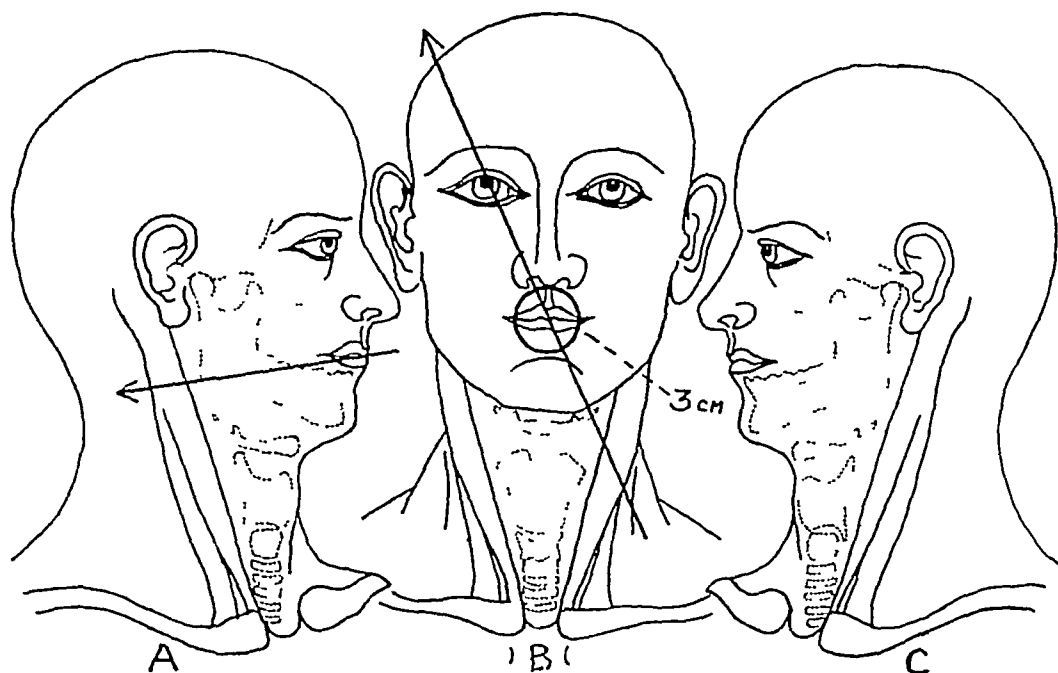


Fig 3 A typical set up for peroral x-radiation of carcinoma of the right tonsil. In A the direction of the beam in the horizontal plane is designated by the arrow pointing from the lips backward through the angle of the jaw. The vertical plane is designated in B by the arrow passing through the center of the mouth and pupil of the right eye. The circle over the mouth in B indicates that a 3 cm peroral cylinder is to be used. Such a record of treatment factors insures a correct and uniform set up for all treatments in a given case.

ing obliquely upward at an angle of 45 degrees from the horizontal level, but this form of apparatus is less flexible than the adjustable tube-holder.

For most cases, we have used x-rays at 200 kv, 30 ma, 65 cm TSD (target-skin distance), and 0.5 mm Cu filter. Radiation of such penetration seems indicated in deeply infiltrating growths (2-3 cm). For more superficial lesions we have, in a few instances, employed x-rays at 100 kv, 5 ma, 35 cm TSD, and 1.0-3.0 mm Al filter. Radiation of such moderate penetration appears to have certain advantages in superficial lesions (less than 1 cm in depth). We have recently installed the apparatus illustrated in Figure 2 with the following factors: 200 kv, 8 ma, 35 and 50 cm TSD, and 0.5 mm Cu filter. In the future, we shall probably employ the 35 cm TSD for most superficial lesions treated perorally.

approached through the open mouth. The tumor should be of such size as to be reasonably well included within the beam of radiation (up to 3.5-4 cm). Teeth in the upper and lower jaws anteriorly may have to be extracted in order to admit a cylinder of the necessary diameter. Inability to separate the jaws sufficiently to admit the peroral cylinder makes it impossible to employ this method.

We have constructed a series of sample cylinders which are kept on hand at the examining chair in the clinic where the treatment is outlined. The suitability in the individual case, and the exact factors of the technic are decided upon and recorded before the patient is taken to the x-ray treatment room, as is illustrated in a typical case in Figure 3. By inspection through the open end of the sample, the proper size of cylinder is selected and the exact direction of the beam in both the

RADIATION THERAPY OF MALIGNANT LESIONS OF THE LIP¹

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TREATMENT of the malignant lip is based upon the position, extent, and site of the lesion, whether or not it is ulcerated and infected, flat, indurated, and whether or not lymphatic glandular involvement is present.

Lymph node involvement is important because the location, type, and condition of the lymph drainage areas considerably influence the method of procedure for their control, along with treatment of the primary lesion. In our series² of 160 treated cases, 22 showed palpable lymph node involvement at the time of admission. The duration of the lesion before treatment determined in most instances the occurrence of lymph node invasion. Neck node involvement was uncommon in cases seen within the first six months from the onset of the local lesion.

The age of the patient is important, the younger the patient the more drastic being the treatment required to control the malignant process, in older patients with localized lesion surgery is often the method of choice and may readily eliminate the entire condition, and irradiation administered post-operatively prevents recurrence and metastases. The youngest patient treated was 21 years old and the oldest was 82 years old. In our series only six females were affected. Occasionally the presence of the lesion may be due to irritation by an irregular, rotten tooth, a poorly fitting denture, or to pipe smoking.

Thirty-four patients were persistent pipe-smokers, 35 were cigarette-smokers, and four were cigar-smokers. Two patients chewed tobacco, 85 smoked occasionally or not at all.

Elimination of the irritant agent is essential before any treatment is attempted. Mouth hygiene must be cared for before irradiation is employed in order to prevent local infection of the involved area and subsequent bone necrosis following radiation therapy, especially in cases in which tooth extraction is required.

The lesion on the lip may be a localized, scaly indurated, dry keratotic area, an ulceration, or a large bulky cauliflower-like growth involving the whole lip and part of the chin. Biopsy is advisable in all cases and is easily effected in the ulcerative type, in the keratotic localized lesion biopsy may at the same time remove the whole condition.

In most cases the lip lesion pathology was squamous-cell epithelioma. In most instances the lower lip is involved, occasionally, however, a malignancy of the upper lip is encountered.

Treatment of cancer of the lip is carried out either by surgery and irradiation or by irradiation alone.

In all cases, whether surgery or irradiation is employed, treatment begins with therapy to the neck gland area draining the lip lesion, followed by local treatment of the lip. Treatment of the neck glandular areas may be with high voltage x-ray or radium therapy. When the former is used, usually both sides of the neck are treated, whether or not palpable lymph nodes are present, a more intensive treatment being given when nodes are already demonstrable. The x-ray therapy is directed to fields sufficiently large to cover the whole neck area, both sides being treated on alternate days, a dose of from 150 to 200 r being given per field per day, a total dose of from 850 to 3,000 r being given each area, depending on the amount of lymph node involvement present. The factors employed are 200 kv, 4-5 ma, 0.5

¹ Presented before the Radiological Society of North America at the Twenty-second Annual Meeting at Cincinnati, Nov 30-Dec 4 1936.

² Period covers the years from 1924 to 1935.

We have successfully employed several variations of technic, such as fractionated peroral x-ray treatment given every other day or even twice a week, if the patient lives at a distance from the clinic. In such instances, the individual doses are raised so as to bring up the total to the required level. In another variation, the total period of x-radiation may be cut down to ten days or two weeks with a corresponding decrease in the total dose of x-radiation and an increase in the dose of radon seeds. The possible number of such variations is unlimited and their indications and success will depend on the experience and ingenuity of the surgeon.

It often happens that the growth regresses so promptly and completely under the fractionated or protracted x-radiation that the supplementary radon seeds may be omitted, but in our opinion, there is so little contra-indication to or disadvantage in the insertion of a moderate supplementary dose of seeds that there is no particular merit in the attempt to accomplish the control of the growth by external radiation alone. Routine attempts to do so will be followed by an unnecessarily high percentage of failures and the unjustifiably severe effects of the large total doses of x-radiation alone.

Similar technics have probably been employed by others, and we make no claim to priority.² We have used such peroral portals since 1931,³ when their advantages for tonsillar and soft palate growths occurred to us. Since that time, we have gradually

extended their application until, at the present time, we find them of great advantage in most tumors of the oral cavity. By this means, the reaction from the x-radiation may be confined to the immediate area of the tumor, while the adjacent normal tissues, such as the jaws, teeth, palate, etc., may be almost completely protected. The disconcerting incidence of osteomyelitis or late radionecrosis is a common experience, especially in those growths which because of their bulk and radioresistance require large tissue doses of radiation. We believe that the incidence and extent of such complications may be greatly lessened by the judicious combination of several precautionary measures, such as the protection of the jaws and soft tissues from too diffuse radiation effects. The peroral portal is simply one of these precautionary measures, others of which are protective dental shields containing lead, the use of small and efficiently placed doses of interstitial radiation, the use of small, carefully centered portals for x-radiation, etc.

Since we have used these peroral portals, there has been a marked reduction in the incidence of osteomyelitis and late radionecrosis in our clinic. The progressive development in the technic of radiation therapy depends not only on the correct application of such broad general principles as fractionation or protraction of dosage, but on a careful attention to and the application of a number of smaller details. With this ideal in mind, the plan and execution of a radiation program becomes just as exact and as dependent on anatomic details as a surgical procedure.

These devices shown in Figure 1 were constructed in the machine shop at the Memorial Hospital by Mr. A. Schreiner and Mr. Kurt Bender, Master Mechanics, whose valuable suggestions as to design are hereby gratefully acknowledged.

² Brickner, in 1903, described the treatment by peroral x-radiation in a case of cancer of the cheek. He used a Ferguson vaginal speculum passed through a hole in a large sheet of lead and into the mouth in the desired direction. (*International Jour Surg N Y* 1903 16, 303-306.)

³ Martin, H. E. and McNattin, R. F. The Treatment of Cancer of the Pharynx, Tonsil, and Extrinsic Larynx by Divided Doses of External Radiation. *Am Jour Roentgenol and Rad Ther*, 1935 32, 717.

tor of wax or rubber, and left in place for sufficient time to deliver the required predetermined dose, which depends on the of radium or millicuries of radon each and the mold is left in place long enough to deliver the required predetermined dose

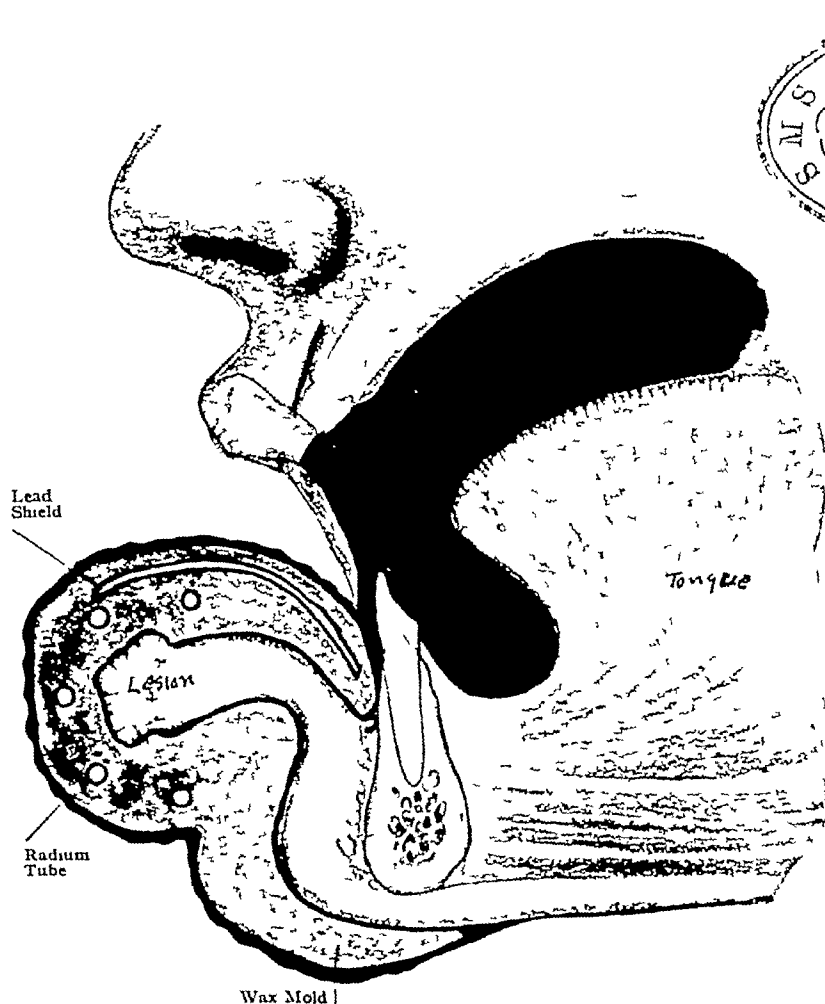


Fig 1 Radium mold (cross-section) showing lead shield and radium tubes in place.

extent and type of the original lesion present and the amount of surgery performed in its removal. The mold is fitted over the lip and is made to extend beyond the chin for fixation. The thickness of the mold varies from 0.5 to 2 cm. To its surface are attached radium tubes filtered through 1 to 1.5 mm of platinum or equivalent. A sufficient number of tubes is used to surround the involved area, the dose given being from 1,000 to 2,500 milligram-hours. The tubes contain from 10 to 15 milligrams

In cases in which block dissection of lymph nodes of the neck is carried out simultaneously with or subsequent to the local lip resection, post-operative high voltage x-ray therapy is given to the neck, a dose of from 800 to 1,000 r units being administered to each area over a period of eight days.

2 *Treatment of the Local Lesion with Radium*—For this, the method employed depends on the location and extent of the lesion. Small localized areas may be

mm copper plus 1 mm aluminum filter, at 40-50 cm distance. The size of the fields used depends on the neck area to be treated, usually 9×12 cm or 10×15 cm.

If no palpable nodes are present, a dose of from 800 to 2,000 r is administered to each side of the neck over a period of from ten to sixteen days. In some cases, especially those with advanced lesions in which interstitial irradiation is not advisable, a modified Coutard method of x-ray therapy is employed, both sides of the neck receiving a dose of from 3,000 to 5,000 r through 2 mm copper filtration at 50-60 cm distance, delivered over a period of 30 days. As a result of such intensive therapy, marked skin reactions may appear and hospitalization be required until the irradiation effect subsides.

Where neck node dissection has been decided upon, pre-operative x-ray therapy is administered to both sides of the neck. The dose given is 900 r per area over a period of six days, 150 r being administered to each side of the neck each day. Operation may be carried out within three weeks following x-ray therapy.

If radium is to be employed for external irradiation, it is applied in the form of a pack. In cases in which large quantities of radium are available, a large pack such as that in use at Bellevue Hospital, New York City, may be used. It consists of 5 grams of radium, distributed evenly over an area of 8×10 cm, filtered through 3 mm platinum equivalent. The pack is applied at a distance of 6 cm from the surface of the neck, and treatment is given each side of the neck on alternate days for a period of 20 days, thus giving 50,000 milligram-hours to each side of the neck.

In cases in which moderate amounts of radium are available, treatment of the neck areas may be carried out by the application of radium molds or small packs. The mold may be of a specially prepared wax and shaped like a collar around the neck. Its thickness varies from 3 to 6 cm, depending on the area and extent of the glandular involvement to be treated. The radium, in the form of tubes, is attached to

the mold and distributed over its surface so as to cover the whole glandular area. The tubes should contain from 5 to 10 milligrams of radium or millicuries of radon, and filtered with 1.5 mm of platinum or its equivalent. The dose is from 10,000 to 20,000 milligram-hours of radium, or 200 millicuries of radon is required for this type of mold.

In some cases in which definite large hard lymph nodes are present, a small pack is attached to either side of the neck. This pack is made of wax, or a wooden block, or a soft rubber sponge upon which is placed the radium in the form of tubes of 10 milligrams each, filtered through 2 mm of platinum or its equivalent in lead. Usually 10 tubes are used, making each pack hold 100 milligrams of radium. The thickness of the pack is such as to separate the radium from the skin by from 5 to 6 cm. The portal size is 7×9 cm. The sides and top of the pack are covered with lead so as to enclose the tubes and restrict the radium rays which are emitted in all directions. The radium rays required are allowed to pass unhindered through the under surface of the pack and directed toward the involved gland area of the neck. The pack is held in place by a head bandage and remains on the patient until the predetermined dose is administered. Usually the dose given with this method is from 35,000 to 45,000 milligram-hours over each area, over a period of from 16 to 21 days.

Following irradiation of the lymph node areas of the neck the local lesion is treated with surgery, radium or x-rays, or a combination of these. During the course of the local treatment the patient is hospitalized.

1 In cases in which the lesion of the lip is localized, with slight induration, and in old persons with small localized lesions, in which no metastatic involvement is visible or palpable, the entire malignant area may be removed by surgical excision. Following healing of the local wound, radium may be applied to the area of operation with a molded surface applica-

the treatment may be ambulatory. The needles are 27–35 mm in length and contain 2 milligrams of radium each. The needle wall filtration is 0.5 mm of platinum. The needles are inserted horizontally in two planes at right-angles to each other at the periphery of the lip lesion so as to form a cross-firing web around and through the lesion. As many needles are used, spaced about 0.5 cm apart, as will completely surround the involved area. The dose given varies with the size of the lesion, approximately from 300 to 500 milligram-hours per cubic centimeter being administered over a period of from two to five days (Figs 4, 4-A, 5, and 5-A).

Technic—Under direct or conductive local anesthesia, the needles, already threaded, are grasped by specially prepared forceps and inserted around the tumor mass. They are kept in place by sutures through the surrounding normal tissues, using the threads already attached to the radium needles. To restrict stray irradiation the lip is covered with a molded lead protector. After the required total dose of from 1,000 to 3,000 milligram-hours is given, the needles are removed and the lesion treated with bland wet dressings until all inflammatory reaction has subsided, whereupon a bland ointment is applied until the lip is healed.

secured $10 \times 2 \times 150 = 3,000$ milligram-hours.

In some cases in which needles are not available and the tumor is quite bulky,

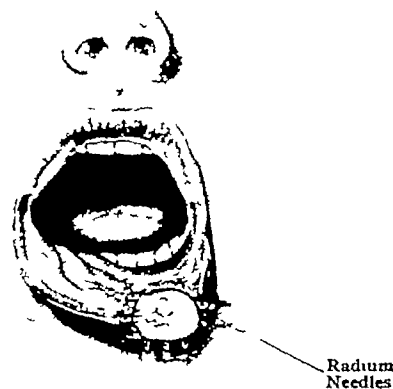


Fig 3 Lesion on lip treated by insertion of radium needles

radon gold seeds are used. The seeds are from 0.2 to 1 millicurie in strength, filtered with 0.3 mm of gold, and are inserted in and around the malignant lesion 1 cm distance apart under local anesthesia. The dose is about 50 to 133 millicurie-hours per cubic centimeter of involved tissue.



Fig 4

Fig 4-A

Fig 4 Squamous-cell epithelioma of lip before treatment
Fig 4-A Squamous-cell epithelioma of lip healed two years after interstitial treatment with radon seeds (1,000 mc-hrs). Same case as shown in Figure 4

If a dose of 1,000 milligram-hours is required and five needles of 2 milligrams are available, these are left in place $100 \text{ hours} \times 2 \times 5 = 1,000$ milligram-hours. With 10 needles, 3,000 milligram-hours may be

The seeds are left in place permanently and in most instances cause no future discomfort. Post-radiation treatment is the same as when needles are employed (Figs 4 and 4-A).

treated by (a) the application of surface molds, or (b) direct contact application of gold seeds

(a) The molds (Fig 1), of wax or rubber, are fashioned over the lip with the radium

so as to surround it. The tubes contain from 5 to 10 milligrams of radium each. The mold remains in place long enough to give the predetermined dose, which is from 1,000 to 2,500 milligram-hours—



Fig 2 Epithelioma of lip (before treatment)



Fig 2-A Healed lesion. Same case as shown in Figure 2

in tube form fastened thereon, with a wax-covered lead shield over the tubes to restrict scattered radiation. The mold is fitted to the entire lip and is made to extend beyond the chin for fixation and is held in place by adhesive or tape bands around the head. It is usually from 0.5 to 1 cm thick, the radium tubes, from two to four in number, filtered through 1 mm of platinum, being affixed over the lesion area

usually from two to five days. In large ulcerated lesions the mold is fashioned in the same manner but is from 1 to 3 cm in thickness, and is so constructed that the lip is pulled outward and downward. In this position the lesion is cross-fired from above, below, and anteriorly by the radium tubes, which are attached to the mold in sufficient number to surround the periphery of the lesion. Tube filtration is from 1 to 2 mm of platinum, depending on the bulkiness of the lesion, and the tubes contain from 5 to 15 milligrams of radium each. The mold remains in place continuously except during meals when it is removed and cleansed and then put back in place until the required dose is given. The dose used is from 1,500 to 3,500 milligram-hours, over a period of from two to six days. The patient perceives little or no discomfort with this method of treatment (Figs 2, 2-A, and 2-B).

(b) For very small lesions and keratotic spots, radon gold seeds may be fastened directly around or on the lesion with collodium and left in place until the required dosage is given. The seeds are from 0.5 to 1 millicurie in strength and are filtered through 0.3 mm gold. The dose used is about fifty millicurie-hours per square centimeter.

Interstitial Radiation—This method of procedure requires hospitalization when radium or radon needles are employed. In cases in which radon gold seeds are used



Fig 2-B Radium mold in place. mold wax 0.5 cm thick, radium, 4 tubes, content 10 mgr each, time, 72 hours, dose, 2880 milligram hours. Same case as shown in Figure 2

the treatment may be ambulatory. The needles are 27–35 mm in length and contain 2 milligrams of radium each. The needle wall filtration is 0.5 mm of platinum. The needles are inserted horizontally in two planes at right-angles to each other at the periphery of the lip lesion so as to form a cross-firing web around and through the lesion. As many needles are used, spaced about 0.5 cm apart, as will completely surround the involved area. The dose given varies with the size of the lesion, approximately from 300 to 500 milligram-hours per cubic centimeter being administered over a period of from two to five days (Figs 4, 4-A, 5, and 5-A).

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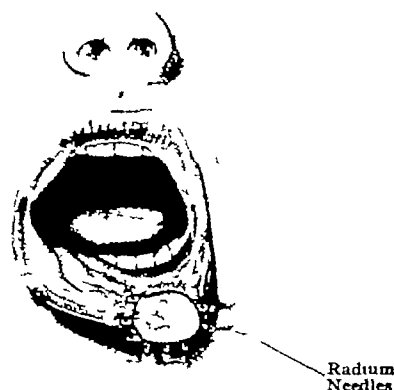


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Fig 4

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If a dose of 1,000 milligram-hours is required and five needles of 2 milligrams are available, these are left in place 100 hours. $5 \times 2 \times 100 = 1,000$ milligram-hours. With 10 needles, 3,000 milligram-hours may be

The seeds are left in place permanently and in most instances cause no future discomfort. Post-radiation treatment is the same as when needles are employed (Figs 4 and 4-A).

Occasionally ulceration necrosis follows interstitial radium therapy, and in cases in which healing does not ensue within a

there is a very large ulcerating, infectious, bulky tumor involvement of the lip, intensive x-ray therapy may be administered



Fig 5

Fig 5-A

Fig 5 Lipthoma of the lip (before treatment)
Fig 5-A Healed lesion after interstitial radium therapy with radium needles 3 needles, 2-9 mc radon content each, 35 mm long, time, six days, 0.5 mm Pb filter, dose given, 660 mc-hrs Same case as shown in Figure 5

short time following treatment with wet dressings or ointments, excision of the involved area with the endotherm or surgical scalpel may be required. Extensive resection may call for subsequent plastic repair. The deformity following treatment depends upon the extent of the original destruction of the lip, being most extensive in the ulcerative types.

In cases in which the malignant lesion extends to and involves the mucosa inside the mouth, the radiation must be planned to include such areas. Lesions at the angle of the mouth present a most difficult condition, and treatment with a radium mold applicator is preferable to interstitial irradiation in this area. The mold is fashioned in the same manner as that for the other portions of the lip, with an additional supporting mold within the mouth.

In those cases in which ulceration or painful scarring persists following radium therapy, necessitating excision and plastic reconstruction of the lip, the upper lip may be used for this purpose according to the methods described by others.

Occasionally, when there is a large, bulky tumor growth, removal of the excessive malignant tissue with endothermy is advisable, followed by radium therapy, in the manner already described.

Intensive X-ray Therapy—In cases in which radium is not available or in which

The x-rays are applied directly to the tumor lesion, the surrounding normal tissues being well screened off by lead or lead rubber shields. This must be done carefully and precisely, for excessive dosage used with this form of therapy is destructive to normal tissues. Before treatment, the protective shield is carefully cut out to fit the lesion exactly. Low voltage, unfiltered x-rays are used. The factors used are 100-150 kv, 4-5 ma, no filter, distance of 30-40 cm, field just sufficient to include the involved area. The dose given is from four to ten erythemas over a period of 21 days, four or five skin erythema doses being administered each day to the involved area. The protective shield about the area is altered to conform to the diameter of the lesion as the treatment progresses, so that exposure to the intensive caustic x-rays is limited to the involved tumor area.

Following treatment, the lesion is handled as would be any second degree burn. In cases in which marked inflammatory reaction takes place, wet dressings are applied for several days and a bland ointment dressing used until the lesion heals. As the tumor tissue is destroyed, healing takes place by the formation of fibrous scar tissue. In severe cases with noticeable defect formation, subsequent plastic excision—well beyond the irradiated tissues, in order to insure tissue properly supplied

with nutrition upon which to build the new lip—is carried out, not, however, until all irradiation reaction effects have subsided

Recurrences—These occasionally appear at the site of the previously healed lesion or just beyond its periphery. When small, they may be eradicated with surgery and the remaining malignant tissue treated with radiation or by insertion of small radon contact seeds.

In cases in which neck nodes persist after irradiation they may be surgically removed or treated with interstitial radium therapy. This is readily effected by inserting radon gold seeds of from 0.2 to 1 millicurie each into the palpable lymph nodes, the number of seeds thus employed varying with the size of the node being treated. A dose of from 100 to 300 millicurie-hours per cubic centimeter is used. The seeds may be inserted into the palpable nodes directly through the skin following local surface anesthesia or the skin may be incised, reflected back and the nodes exposed and localized and the seeds more accurately inserted in them.

During the course of treatment, due regard to general body health is required. Occasionally eating is rendered difficult because of the presence of radium application or soreness of the lip. Sometimes intensive irradiation may produce an inflammatory radiation reaction on the mucosa of the mouth and in such cases special care in feeding is essential to the patient's well-being. In some instances gavage or rectal feeding may be required, and occasionally hypodermoclysis, intravenous infusions of glucose or transfusions are necessary to bolster up the patient's general strength.

Following healing of the primary lesion, the patient is advised to protect the treated area against subsequent injuries. Nightly application of a bland ointment is advised to keep the healed irradiated tissues in soft condition.

In 1935³ we reported on the results of irradiation treatment of 93 cases on the Bellevue Hospital Radiation Service, since

³Kaplan, Ira I., and Krantz, Simon. *Am Jour Roentgenol and Rad Ther* September, 1935 34

then 67 cases have been added to our series, with even more beneficial results being noticeable.

CONCLUSIONS

A study of our cases leads us to the following conclusions:

Carcinoma of the lip is most commonly present in males over 40 years of age.

It rarely occurs on the upper lip.

Chronic irritation is an important factor in the etiology and excessive smoking has been indulged in by most of those so afflicted.

Syphilis is of little influence as only a very small number, less than 2 per cent, gave a positive Wassermann reaction.

Metastatic lymph nodes were not common concomitant occurrences in most cases and, when present, indicate advanced disease with poor prognosis. Local recurrence and metastasis were infrequent sequelæ in cases which did not exhibit lymph node involvement before the local lesion was treated. Lymph node metastasis occurred infrequently in cases in which the local lesion had been completely eradicated by intensive treatment.

The results of irradiation in cancer of the lip, based on our study of 160 cases, compare favorably with those following surgery, with the added advantage of no immediate operative mortality, moreover, mutilating scars are very much less likely to occur following irradiation.

55 East 86th Street

DISCUSSION

DR WILLIAM E. COSTLOW (Los Angeles, Calif.) Dr. Kaplan has very completely covered the problems of surgery and radiation in the treatment of cancer of the lip.

Fortunately, malignancy of the lip is quite amenable to treatment, first, because it is accessible, and second, because it is the lowest grade of malignancy of the intra-oral growths. The majority of the growths are of Grade I and II, Broders' classifica-

Occasionally ulceration necrosis follows interstitial radium therapy, and in cases in which healing does not ensue within a

there is a very large ulcerating, infectious, bulky tumor involvement of the lip, intensive x-ray therapy may be administered



Fig 5



Fig 5-A

Fig 5 Epithelioma of the lip (before treatment)

Fig 5-A Healed lesion after interstitial radium therapy with radium needles 3 needles, 2-9 mc radon content each, 35 mm long, time, six days, 0.5 mm Pb filter, dose given, 866 mc hrs Same case as shown in Figure 5

short time following treatment with wet dressings or ointments, excision of the involved area with the endotherm or surgical scalpel may be required. Extensive resection may call for subsequent plastic repair. The deformity following treatment depends upon the extent of the original destruction of the lip, being most extensive in the ulcerative types.

In cases in which the malignant lesion extends to and involves the mucosa inside the mouth, the radiation must be planned to include such areas. Lesions at the angle of the mouth present a most difficult condition, and treatment with a radium mold applicator is preferable to interstitial irradiation in this area. The mold is fashioned in the same manner as that for the other portions of the lip, with an additional supporting mold within the mouth.

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Following treatment, the lesion is handled as would be any second degree burn. In cases in which marked inflammatory reaction takes place, wet dressings are applied for several days and a bland ointment dressing used until the lesion heals. As the tumor tissue is destroyed healing takes place by the formation of fibrous scar tissue. In severe cases with noticeable defect formation, subsequent plastic excision—well beyond the irradiated tissues, in order to insure tissue properly supplied

presenting in the ampulla of the rectum which proved, on biopsy, to be a hemangioma. Considerable bleeding followed the removal of a section of this tumor.

Other conditions which may simulate carcinoma of the rectum are inflammatory strictures, tuberculosis, and amoebic ulceration.

In regard to the treatment, it may be interesting to compare the treatment used by Dr. Bowing with that followed at our institution. Given an inoperable—or operable—case of cancer of the rectum, external x-ray is applied, using 200 kv, 25 ma, at a distance of 80 cm, with 0.5 mm of copper filtration, 200 r are applied daily, alternating front and back of the sacrum and lower abdomen. A total dose of 3,000 r as measured in air is given on each side.

In conjunction with this, some form of interstitial radiation is administered—radon seeds in selected cases, with 0.3 mm of gold filtration. Direct application of radium tubes in tandem, 100 mg each, is made to the tumor area for four hours every other day, for a total of 4,000 milligram-hours.

Another form of external treatment, the radium pack, is used: three ports, a gram and one-half of radium to each port, using a daily dose of 200 r, alternating front and back, until we build up a total dose of 5,000 r on each skin surface.

We do not fulgurate malignant tumors of the rectum as described by Dr. Bowing. The bleeding sometimes subsides even before the conclusion of the treatment. There is sufficient destruction of the tumor tissues.

I want to emphasize also what Dr. Bowing has said about the fact that radium and x-ray should be used in conjunction with surgery—additional equipment for the use of the surgeon. Only by co-operation of the surgeon, radiologist, and internist will we be able to lower the high mortality rate in carcinoma of the rectum.

DR. WALTER S. LAWRENCE (Memphis, Tenn.) Discussing Dr. Kaplan's paper in justice to a few young men who are in

the house who may not have had as long experience as some of the rest of us, I would like to suggest that I believe Dr. Kaplan's method will cure practically all cases. But I also believe that if one had a very persistent and annoying wart on the tip end of his tongue, where such do sometimes occur, that if the tongue were brought forward and fixed outside of the mouth for a given time, screened off with a piece of lead on top of it and given 4,000 r from a 1,250,000 volt x-ray machine, such treatment would cure the wart.

In other words, I believe that the majority of these cases of cancer of the lip may be cured by somewhat easier, less expensive, and less persecuting methods than those advocated.

I have nothing to say in criticism of his method of treating carcinoma of the lip that has glandular metastasis. I think in these cases the best is none too good. But in treating a great many of these cases, I think we have to consider the social status, the financial status, and the amount of persecution which the patient is willing to stand to get rid of his possibly not very serious lesion. All of them are serious, but certainly many of them can be entirely obliterated and remain well for the rest of the patient's life by methods somewhat less expensive, less persecuting, and simpler than those Dr. Kaplan advised in some cases.

Of course, if the patients are wards of the State, the amount of money we spend on them and the amount of trouble we go to merely means practice to our understudies who do most of the work. Or if the patient is immensely wealthy, we can give him as much treatment as would seem reasonable or unreasonable, but in the ordinary "run of the mine," the man who is making his own living and needs the use of his lip and tongue and other parts of his mouth daily, I think he can be treated in an easier way.

Before closing I want to mention one thing that I do not believe Dr. Kaplan mentioned—the protection of the mucosa, of the gums, and the tongue by fitting

tion Practically 90 per cent fall in this group, which is undoubtedly the reason why they are slow to metastasize and are more amenable to treatment

I disagree with Dr Kaplan in his statement that in all cases of lip malignancy the gland-bearing areas should be irradiated regardless of whether surgery or radium is used in treating the primary lesion In the past eleven years, in a series of 630 cases of lip malignancy treated in our clinic, approximately 10 per cent did not have glands at the time the primary lesion was treated, nor did they develop glands later Had we irradiated the neck glands in all of these cases, we would have treated at least 90 per cent unnecessarily

I do not believe that there is any more justification for the routine irradiation treatment of the neck glands in carcinoma of the lip than there is for the routine block dissection, which has been discontinued for a number of years

In order that the irradiation treatment of malignancy in neck glands shall be efficacious, it must be very thorough Even though glands are not palpable and we are treating the neck on the supposition that malignancy is present, it is about a 90 per cent chance that it is low grade malignancy, squamous cell with pearl formation, highly radioresistant Consequently, it would be necessary to give a very radical irradiation treatment We do not believe that it is justifiable to subject the patient to such a radical treatment unless there is definite evidence that pathology is present in the glands

Another reason Suppose we should go ahead and give this thorough irradiation to the neck glands, then a few months later the patient should develop a metastatic area, we would be greatly handicapped in any further treatment We would be hesitant to go ahead with another radical fractional irradiation treatment, and even surgical resection would be difficult

We have had some experience with surgical resection in some of these cases and find it is very difficult on account of the severe fibrosis produced by the previous

irradiation This treatment might be justifiable in high grade malignancies, in young individuals In some cases in which the previous biopsy showed a high grade malignancy—for instance, a Grade IV Broders' classification—we have proceeded to irradiate all the neck glands All these patients have eventually died of cervical metastasis

I believe that Broders found the same results in going over the material at the Mayo Clinic, namely, all the patients with lip cancer, Grade IV, are dead

Speaking of the youngest cases—the youngest patient in our series was 12 years of age This was a Grade I epithelioma, and the patient has been well for three years

Our plan of treatment is to apply radium to the primary lesion We prefer radium on account of the better cosmetic results

I wish to compliment Dr Kaplan on the very beautiful primary results he has shown here We agree perfectly with him regarding his methods of treatment of the primary lesion

In cases in which there are glands present, we proceed with a thorough fractional irradiation to the neck glands Ordinarily, that is all we do, we depend on that In some cases in which a localized mass persists later, which apparently is not completely adherent and apparently has not broken through the capsule, we have attempted resection Surgery usually is reserved until the later manifestations following extensive irradiation

We have practically given up interstitial irradiation in the treatment of the neck glands

DR JOSEPH P O'BRIEN (Buffalo, N Y)
Dr Bowing mentioned the advisability of removing a section for diagnosis A section certainly should be taken for diagnosis and, if positive for malignancy, other factors of importance may be determined—the grade of malignancy, metastasizing possibilities, the prognosis, etc

Interesting in respect to that phase are several cases one, a large spongy tumor

cerations, absolutely not amenable to any kind of treatment whatsoever

Dr Lawrence uses perhaps the dermatological method of treating cancer. You sometimes can treat cancer that way. Occasionally we can remove the whole carcinomatous lesion of the lip with the biopsy—also that has occurred with us.

Unfortunately I did not have the photographs with me to show you the cases treated solely by x-ray therapy. We do treat with low voltage x-ray therapy, as Dr Lawrence suggested, but we use a little heavier filtration of aluminum, and we get good results.

As far as economy is concerned, you were right. When it comes to the ward cases we are not so particular how much free money we spend. We just spend it! When we have the rich person, we try to spend his money. But you find he is the most difficult man to get to pay his bills, so for

him we must reduce the amount of time we require for treatment.

The middle class patient who requires a radium mold comes to us on Friday, is placed in a private hospital at a minimum rate, keeps the mold on Friday, Saturday, and Sunday. Monday morning we take it off, and he goes to business that day. Thus he loses practically a little over a working day, which isn't much to pay for cancer treatment. And we judge our rates according to the patient, of course. The cost of treating patients that way, with a small radium mold and with ambulatory treatment in the office of the x-ray therapist, is really inconsiderable. It is not to be considered at all when you figure that, after all, one of these cases may be extensive carcinoma.

So if you treat them all alike, the easy ones and the hard ones, in the long run you are going to do something for carcinoma that is really worth while.

pieces of lead rubber over them. If the lesion is in the corner of the mouth, you can cut the rubber so as to slip it around, and with the patient closing his mouth, the lead rubber will protect the upper gums and the lower gums, and avoid the necessity of a great deal of pain from reaction if we are going to give extremely large doses to the outside.

Now continuing the point of using less extreme measures—they *will* cure, unquestionably, but I believe other methods will cure also.

The first case of cancer of the lip that I ever treated, some twenty-eight years ago, I gave x-ray therapy, but how much or how little no one knew at that time. I do know that I gave the man 27 treatments, a little tiny bit every other day, and I do know that he had a large lesion on the front of his lip, of quite long standing. It was of the squamous-cell type, I admit, but he got entirely well and remained entirely well for 25 years.

My method of treating these cases is to put a piece of soft lead rubber in the mouth and give about one and a half erythema doses, filtered through about four millimeters of aluminum, which takes possibly ten to fifteen minutes. I repeat that dose once a week until healing is well on the way, generally giving not over three treatments.

One other point. I do not believe it is wise to treat the gland-bearing area unless it is involved, in some measure anyway. I think if it does nothing else, it lowers the resistance of that tissue, particularly if you give it 2,000 or 3,000 r.

I enjoyed Dr. Kaplan's paper ever so much and I am sorry I felt it necessary to make a little criticism of it.

DR. IRA I. KAPLAN (closing). It is hard to assume the responsibility for everything one says without being able to demonstrate exactly why one feels that that is the correct thing to do. We have an opportunity in our service in the Cancer Division of the City Hospital organization, of which I happen to be the Director, of having at our disposal a hospital of

200 beds for custodial cancer cases only. It is the largest in the United States for that purpose. There we receive patients from every hospital in New York City and from private physicians who have cases that no longer can support themselves, and thus we have an opportunity of observing in these numerous cases—over a thousand a year—just what happens in cancer conditions that have been treated elsewhere by all sorts of methods. Our death rate is about 90 per cent, and we therefore are dealing with the cases that have been treated by almost every method and have been abandoned. In that way we learn what has happened when other methods have been used.

Our methods as described to day are not always the best methods. We know that, because even from our own service at Bellevue we must occasionally transfer cases to my other service at the Cancer Institute.

We may be right in our own way, or we may be wrong, as Dr. Costolow and Dr. Lawrence say, in treating gland-bearing areas with pre-operative or pre-local radiation. We have a certain responsibility to our patients and we would rather make the mistake on the safe side than take a chance otherwise. We have found that if we are required later to irradiate patients for glandular metastasis, who were not irradiated pre-operatively or before receiving radium therapy, the condition is almost hopeless and much more difficult to control. For that reason we believe that we must first irradiate all cases over the gland-bearing area and then treat the local lesion.

Dr. Lawrence is quite right in saying that we can treat some of our lesions in a mild manner, but how often have all of us seen carcinomatous conditions recuperate, as it were, grow again, and create a condition that is horrible in the end. Those last two slides that I showed you were of cases treated just that way—in a temporizing manner. One was treated in a very good hospital—had a radical resection of the lesion, and then you saw the neck all breaking out with malignant ul-

Past History—She had been a normal baby, weighing eight and a half pounds at birth. She was breast-fed for 13 months

draining from the left lower molar region. Her jaw had been swollen for two and a half years prior to this time. A diagnosis

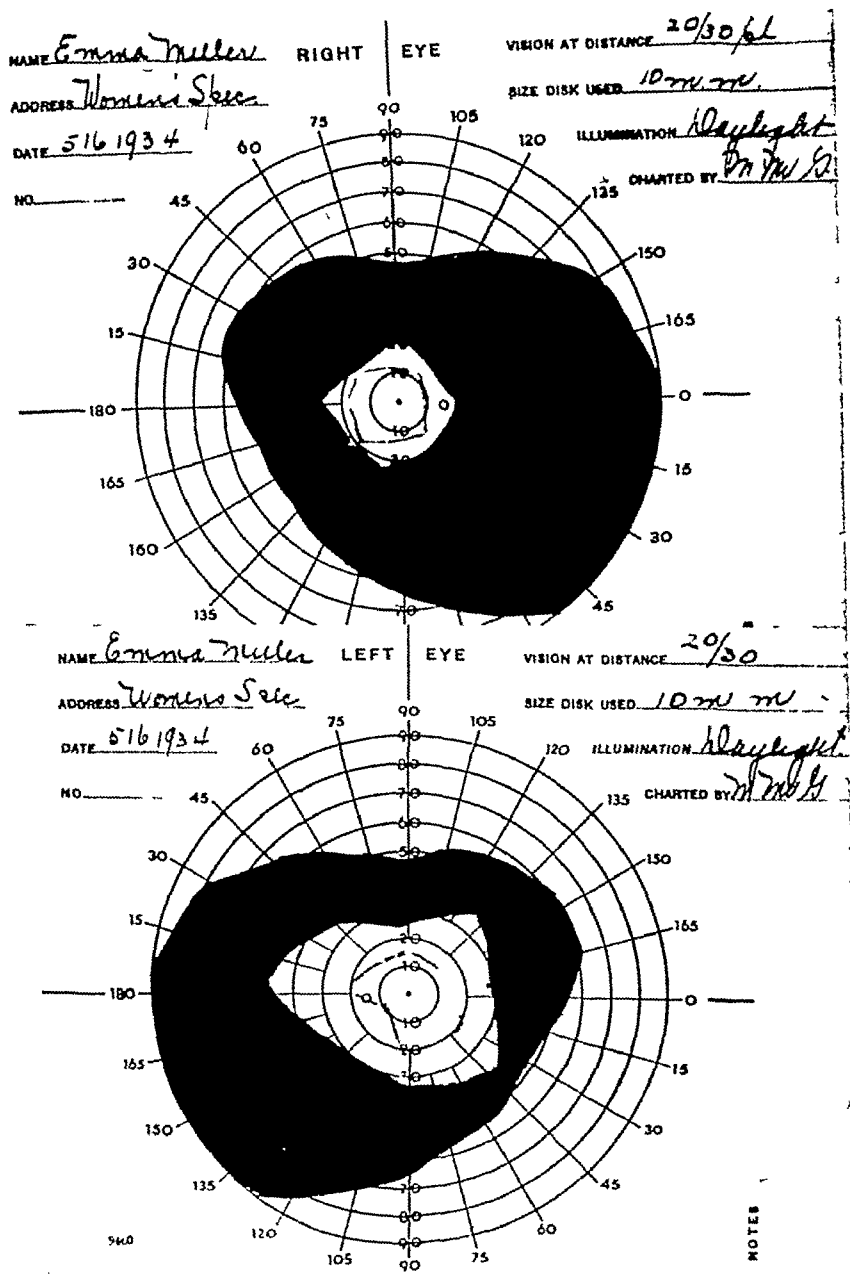



Fig 1 Visual fields show no optic atrophy

Her health was good until the age of five, when she began to complain of "sore teeth". In September, 1930, at the age of nine, she was admitted to the Ohio Valley General Hospital because of pus

of necrosis of the mandible was made. A sequestrum was removed from this area two months after admission. There was a marked secondary anemia (hemoglobin 50 per cent, red blood cells, 2,500,000). Aside,

OSTEOPETROSIS¹

By R. MANGES SMITH, M.D., Department of Roentgenology, and AUSTIN T. SMITH, M.D., Department of Rhinology, Jefferson Medical College, Philadelphia

 OSTEOPETROSIS, more commonly known as marble bones, was described originally in 1904 by Albers-Schonberg (1). The condition first appeared in the English literature in 1922, when G. G. Davis (2) collected seven cases from the foreign literature and added another one. Various names have been used in referring to the condition, i.e., Albers-Schonberg disease, *marmorknochen*, or marble bones, lime gout, osteosclerosis with anemia, and osteosclerosis fragilis generalisata. The name "osteopetrosis" was suggested and used by Karshner (3) in 1926. It is not entirely suitable, because literally it means "stone-like bone," whereas, Pirie (4) showed the bones to be more like chalk in consistency. For the same reason, "marble bones" is a misleading term, despite the fact that the outstanding characteristic is a generalized increased radiopacity of the bones resembling marble. Another characteristic is the fragile nature of the bones. It might be better to use a term more descriptive of this chalk-like consistency, such as osteocretosis.

The etiology of this condition is unknown. Observers agree on an abnormal calcium metabolism of the bones but cannot satisfactorily explain it. The rôle of the parathyroid secretion and vitamins has not been established. In many cases serum-calcium and phosphorus have been studied without indicating any definite variation from normal. Hereditary influence is considered a strong factor. Howard Pirie (4) reports a study of four cases in one family—the mother and her three children. In one child the condition was first suspected while it was a fetus *in utero*, due to the density of the verte-

brae as seen roentgenographically. After birth, examination revealed the early stages of marble bones. Pirie studied the increase in the condition as age advanced. He suggested that infection plays a more important rôle in the production of the condition than endocrine disturbances.

The symptomatology varies, depending upon the stage to which the condition has advanced. The liver and spleen are frequently enlarged. Anemia is common, due to transformation of the medullary canal into compact bone. Imperfect dentition is usually present due to disturbance of the dental calcification as well as to a poor blood supply. Frequently, the mandible is necrotic because the main blood supply is cut off and there is no collateral circulation. The cranial nerves are often involved due to pressure on them because of bony changes in the canals. Poor eyesight and blindness are not uncommon. In a number of cases the condition was first discovered when spontaneous fracture of a bone occurred. The bone becomes chalky and fragile from the excess calcium.

CASE REPORT

This report of another case of osteopetrosis is presented not only because of its rarity and its mysterious etiology, but also because it emphasizes the importance of its recognition. This patient was referred for treatment of a chronic right maxillary sinusitis. In addition to the usual roentgenologic appearance of the skeleton, this case presents some unusual features.

The patient, a white female, aged 13, was admitted to the Jefferson Medical College Hospital, May 9, 1934, on the service of Dr. Fielding O. Lewis. Her chief complaint was a discharging sinus underneath the right eye, which had persisted for ten months.

Family History—Negative

¹ Presented before the Radiological Society of North America at the Twenty-second Annual Meeting at Cincinnati, Nov. 30-Dec. 4, 1936.

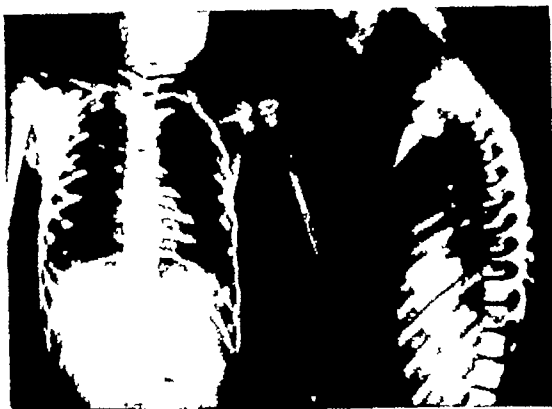


Fig 6



Fig 7



Fig 8

Fig 9

Fig 6 Heart and lungs are normal
Fig 7 Thoracic vertebrae, ribs, and sternum show uniform increased bone density

Fig 8 Liver and spleen are normal

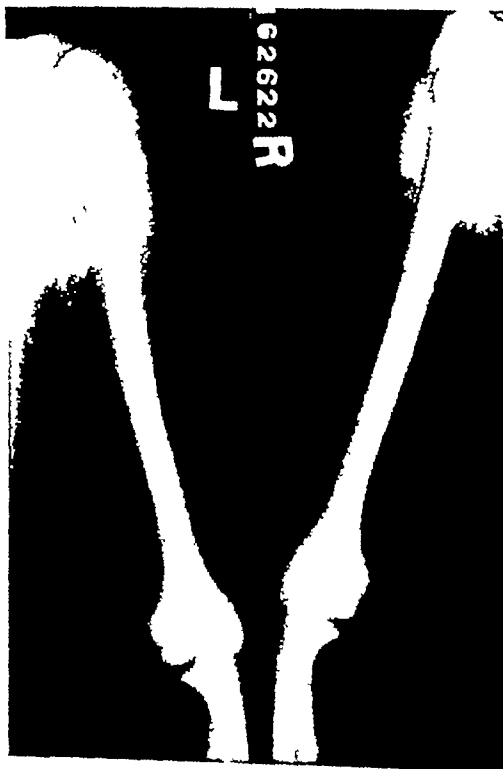
Fig 9 Lumbar vertebrae and bones of the pelvis are quite dense

appearance of the pituitary fossa would indicate probable pituitary disturbance"

Present Illness—The infection in the left mandible subsided, and the child's condition was satisfactory until June 1933. At this time there was pain and swelling beneath the right eye. The swelling gradually increased to include the entire eye and was accompanied by a high fever. Three or four days after onset an incision was made underneath the right eye and a large amount of pus escaped. Drainage persisted until admission to the Jefferson Hospital. A month prior to admission a sequestrum of bone was discharged. She had a continued fever of 99 to 100°.

Physical Examination—The patient is an anemic young female aged 13. The lower part of her face is very small and out of proportion to the rest of the head. She has much the appearance of an edentulous old woman. There is swelling of the right side of the nose and infra-orbital region with a sinus underneath the right eye from which foul smelling pus is draining. The right nasal chamber is filled with pus coming from the right middle meatus. The sinus opens on to the cheek from the right antrum. The teeth are in very poor condition. The tonsils are enlarged. The remainder of the physical examination is negative. The laboratory

studies show a marked secondary anemia but nothing else of importance. The blood calcium is 9.79 mg and the blood phosphorus 4.9 mg per 100 c c. The eye grounds appear paler than normal but show no optic atrophy (Fig 1).



Figs 10 A and 10 B The bones of the extremities show marked increase in density. There is clubbing and shelving of the diaphyses.



Fig 2

Fig 3

Fig 4

Fig 2 Frontal sinuses absent, bones of the face show an increase in density

Fig 3 Maxillary sinuses quite dense

Fig 4 Bones of the skull dense The sella turcica is of normal size.

from the secondary anemia the laboratory studies were negative. Blood calcium was 11.7 mg per 100 c.c. An x-ray diagnosis of chronic osteomyelitis of the left lower jaw was made. On her second admission to the same hospital in March, 1931, the

infection. An x-ray study of the chest, skull, and bones of the legs was made and reported as follows: "There is a general constitutional bone condition present, having the appearance of marble bone, with no definite bone structure present

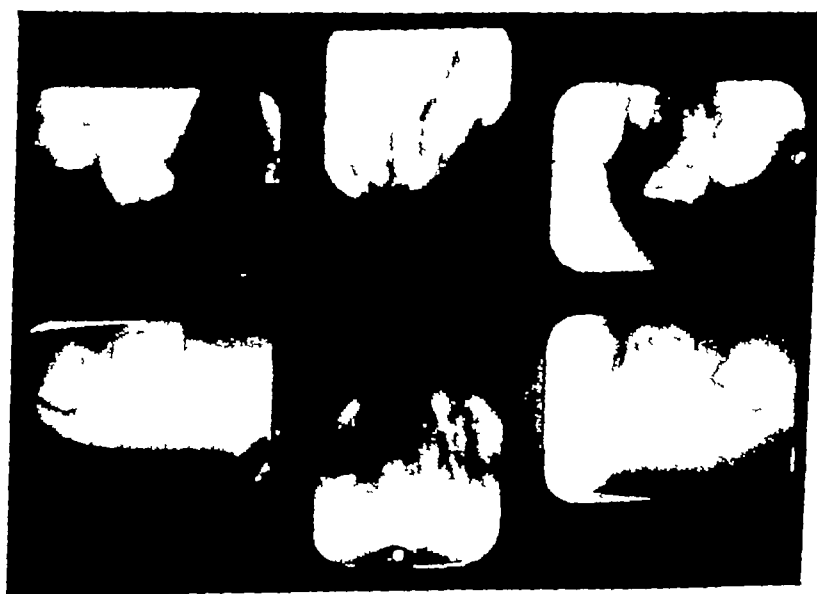


Fig 5 Imperfect dentition, infection and caries of the erupted teeth

jaw was still swollen. Another piece of necrotic bone was removed and some infected teeth were extracted. Cultures of pus from the mandible showed a mixed

at any point. The pituitary area shows very dense clinoid processes and sella turcica. The pituitary area is encroached upon, apparently by thickened bone. The

The carpals, metacarpals (Fig 11), tarsals, metatarsals (Fig 12), and phalanges all show marked involvement

COMPARATIVE STUDY

We were fortunate in being able to make a comparative study of this case

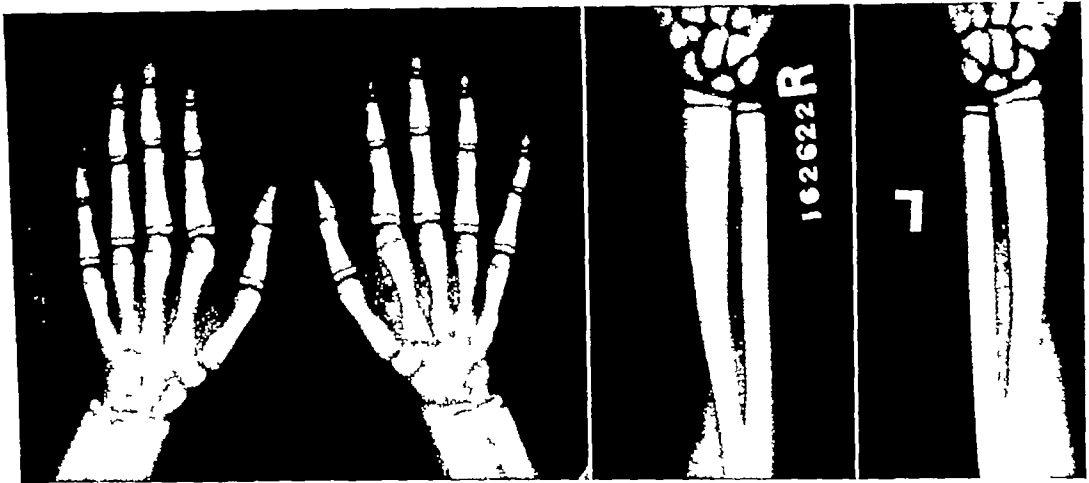


Fig 11 The carpals and metacarpals show uniform increased density

There are no areas of softening in the carpal or tarsal bones. In the epiphyses of the terminal phalanges of both great toes there is a longitudinal break in continuity. It is as though the center of these epiphyses had softened and separated, each one into two parts (Fig 12).

with the one reported by Shallow, Davis, and Farrell (6). Despite the fact that our patient was younger in years than theirs, as evidenced by bone density, the disease was more widespread and uniform in distribution (Chart I). There was no evidence of cross-striations in the epi-

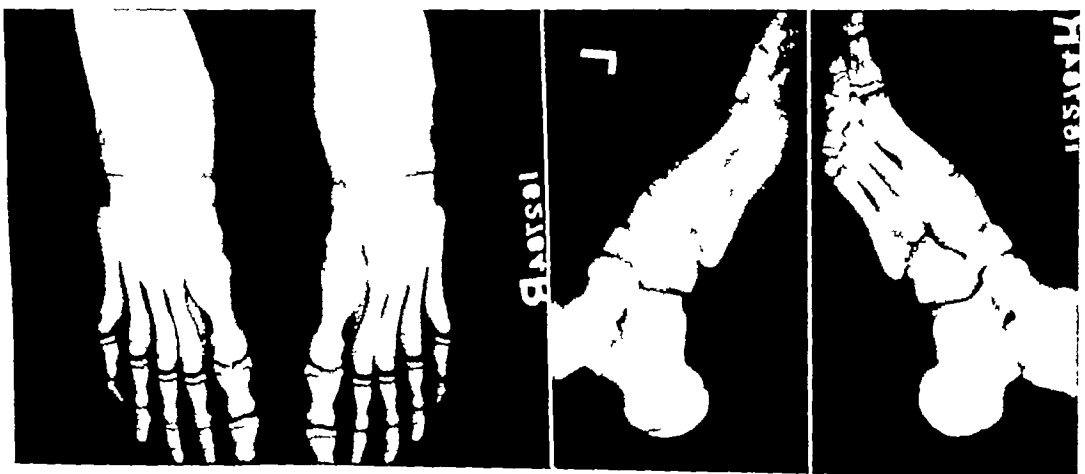


Fig 12 The tarsals, metatarsals, and phalanges are increased in density. There is a softening in the epiphysis of the proximal phalanges of both great toes.

There is no evidence of old or recent fracture in any of the bones of the skeleton. This is a typical case of osteopetrosis.

physeal ends of the diaphyses of the long bones. Since the transverse bands of density are lost, it is reasonable to assume

Roentgen Examination—Because of the draining sinus, films of the sinuses were first taken. A diagnosis of osteopetrosis was made. The rest of the skeleton was studied subsequently.

processes, and in the upper right bicuspid region there is infection of the alveolar processes (Fig 5). This is probably a part of the lesion producing the discharge from the draining sinus.



Fig 10 B See caption under Figure 10 A

The frontal sinuses are absent (Fig 2). The other paranasal sinuses are so dense that they appear to contain no air. The bones of the face and skull all show a uniform increase in density. Both maxillae are quite dense and there is no evidence of bone destruction (Fig 3). The density is perhaps more marked in the right maxilla. The density is so great that it precludes the possibility of determining the site of the draining sinus. The bones comprising the base of the skull are very dense. The sella turcica is normal in size, the posterior clinoids are club-shaped and quite dense (Fig 4). There is no evidence of increased intracranial pressure. The left orbit is slightly larger than the right one.

The mandible does not show the same extent of involvement in the process as the rest of the bones. There is no evidence of the previous necrosis. The imperfect dentition is marked. The erupted teeth lie at odd angles. The erupted teeth are carious and infected. There is marked recession of the alveolar

The heart and lungs are normal in appearance (Fig 6). The paratracheal lymph nodes on the left side are enlarged. The ribs, sternum, and thoracic vertebrae all show the typical increased bone density of osteopetrosis (Fig 7).

The liver and spleen are slightly enlarged (Fig 8). The kidneys are normal in size and occupy a normal position in the abdomen. The lumbar vertebrae are more completely involved in the process than the thoracic vertebrae. The bones of the pelvis, sacrum, and coccyx are quite dense (Fig 9).

There is clubbing and shelving of the diaphyses of the long bones of the extremities. The epiphyses and diaphyses of these bones show a marked increase in density. The epiphyseal lines are irregular due to softening. The age-development of the epiphyses appears to be normal. There is little evidence of cross-striations in the diaphyses of the long bones, which seems to indicate that the condition is long-standing (Fig 10).

DISCUSSION

DR SAMUEL BROWN (Cincinnati) It may be of interest to you to know that I have at the present time six cases of marble bones under observation and all were found in the same family. The hereditary tendency is self-evident.

DR ALFRED C SIEFERT (Oakland, Calif) I would like to ask Dr Smith

whether these patients were foreign-born or whether they were native Americans.

DR CLERF (in behalf of Dr Manges Smith) Unfortunately, I cannot answer that question.

DR BROWN I can answer about the six cases I have; they are all of them American-born.

that either there was no interruption in the activity of the disease or that the disease had progressed to such an extent that cross-striation had been obliterated. Clubbing and shelving of the epiphyseal

not made in their case, and we were unable to determine if there were any areas of softening similar to those seen in the epiphyses of the terminal phalanges of the great toes in this case.

CHART I COMPARISON BETWEEN THE OUTSTANDING FEATURES OF THIS CASE WITH THE ONE REPORTED BY SHALLOW, DAVIS, AND FARRELL (6)

	E M (Author's Case)	M F (6) (Case of Shallow, Davis and Farrell)
Sex	Female	Female
Age	13	16
Skull	Bones thinner	Bones more dense
Sella	Normal	Unusually small
Sinuses	Obscured	Obscured
Maxilla	Necrotic	No infection
Mandible	Not infected	Complete sequestration
Dentition	Imperfect	Imperfect
Vertebra	Normal architecture	Cervical vertebrae show softening
Extremities	Uniformly dense	Multiple cross striations
Femora	Clubbing	Clubbing
Tibiae	Shelving	No shelving
Pelvis	Osteomas	Normal development
Feet	Areas of softening in epiphysis of great toes	Not x rayed
Fracture	No evidence	Multiple rib fractures (old)

ends of the diaphyses of the femora and tibiae is more marked in this case. This is another indication of the duration of the condition. There are osteomas on each descending ramus of the pubis. These proliferative changes were not evident in their case.

In this case the mandible was well preserved—the bone was less dense than bones elsewhere. Dentition was poor due to disturbance of calcium balance rather than to poor blood supply. The prominent feature of the case of Shallow, *et al*, was complete sequestration of the mandible.

The tables of the skull are thinner in our case. The sella turcica is normal in size and the clinoids are increased in density, in their case the sella was unusually small. The architecture of the bodies of the cervical vertebrae was well preserved in this case while in the other one, the anterior, superior surfaces of these bodies were irregularly softened and somewhat flattened.

There was no evidence of old or recent fracture of any of the bones of the skeleton, while in the other case there were multiple rib fractures.

Unfortunately, films of the feet were

SUMMARY

(1) A case of so-called osteopetrosis is discussed in detail.

(2) The more descriptive term of "osteocretosis," literally "chalky bones," is suggested for this condition.

(3) The classical skeletal changes are present, along with necrosis of the maxilla.

(4) An unusual longitudinal area of softening in the epiphyses of the great toe terminal phalanges is described.

(5) The imperfect dentition, which is usually a feature of osteopetrosis, is illustrated.

(6) Certain features of this case are compared with those reported by Shallow, Davis, and Farrell (Chart I).

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Terms—"Tonus"—the tone of the musculature of the colon as evidenced by the haustral markings and by the diameter of the lumen of the colon "Motility"—the movement of the walls of the colon in either or both transverse and longitudinal axes "Emptying time"—the time required, in days, to clear the colon of its barium content

RESULTS

General Controls—Of the 48 cases of dementia præcox, the colon tonus was abnormal in 75 per cent, in 44 per cent it was decreased, and in 56 per cent it was increased. In 71 per cent of the cases the colon motility was abnormal, *i e*, decreased. The time required for the emptying of the barium enema ranged from four to 14 days.³

Specific Controls—Of the 12 cases used, the colon tonus was normal in four and decreased in eight cases. The motility of the colon was normal in three cases and decreased in nine cases. The time required for the emptying of the barium enema ranged from four to 12 days.

Mecholyl—After the injection of mecholyl, in every instance there was marked evidence of an increase in the tonus and in the motility of the colon. As each colon was followed under the fluoroscope there were at first irregularly scattered areas where the tonus would suddenly appear to be increased as evidenced by a deepening and irregularity of the haustrations. These haustrations would frequently disappear entirely, leaving a spastic area from which the barium would be entirely evacuated. As suddenly as the increased tonus appeared, it would in many instances disappear and there would appear in another place another area of increased tonus. In some cases the movement of the colon would be so marked that x-ray films when taken would be definitely blurred. The increased tonus and motility were not confined to any one specific portion of the co-

lon, but in an irregular and general way occupied the entire colon and rectum. They appeared in five minutes, rapidly reaching a maximum of effect at that time and continued thus for more than an hour, after which the colon appeared to have an increased tonus for at least 24 hours. In some of the cases, in addition to the increased tonus as evidenced by increase in the haustral markings and irregularity, and the decrease in the transverse diameter of the colon, there would be a definite decrease in the long axis of the colon, sagging loops would be straightened and marked flexures would tend to flatten out.

Due to the increased tonus and motility, during the first 30 minutes the patients would have one or more evacuations which were imperative and which could not be restrained. The mecholyl did not appear to affect the anal sphincter, and any attempts which were made to retain the barium were purely voluntary and unsuccessful. In every case at the termination of the 24-hour period there had been two, three, or four evacuations resulting in a colon which was practically free of barium.

Mecholyl and Atropine—In those cases in which mecholyl and atropine both were administered, the atropine was given 20 minutes after the mecholyl, *i e*, at the height of the mecholyl action. As the atropine effect would manifest itself, the increased tonus and motility of the mecholyl would become definitely lessened and in some instances disappear, sometimes the colon would appear larger in its transverse diameter than before. Occasionally a definite imperative urge to evacuate would slowly disappear as the atropine became effective and as the patient was observed under the fluoroscope, the rectum would enlarge and the increased tonus become less. In cases wherein such evacuations were presented at the end of 24 hours, the colon still retained large amounts of barium, in marked contrast to those patients who had received only mecholyl. At the end of 24 hours the relaxed colon had returned to approximately its original state of tonus and motility.

³ The detailed study of the colons of this group of cases will be reported at a later date.

HUMAN AUTONOMIC PHARMACOLOGY

V—THE EFFECT OF ACETYL-BETA-METHYLCHOLINE (MECHOLYL) ON THE ATONIC COLON¹

By A MYERSON, M D, PURCELL G SCHUBE, M D, and MAX RITVO, M D, *Boston*

From the Division of Psychiatric Research aided by grants from the Rockefeller Foundation, the Commonwealth of Massachusetts, and the Milton Fund, and the Psychiatric Clinic of the Boston State Hospital

THE importance of the presence of choline derivatives for the maintenance of normal gastro-intestinal function was first demonstrated by Weiland (1) in 1914 and again by le Heux (2) in 1918. They showed that the isolated gut contained choline and that the activity of this gut decreased as the choline was washed out. The action of choline itself was feeble, but, when in the gut and changed to acetylcholine, it was found to exert an influence many times greater. Acetylcholine was thereupon regarded as a peristaltic hormone, and in 1921 Loewi (3) showed that there was a general relationship between acetylcholine and parasympathetic action, and that the action of the drug upon the parasympathetic nervous system was stimulative.

During this time a number of choline esters have been synthesized—all apparently having a stimulative action upon the parasympathetic nervous system. Among them is acetyl-beta-methylcholine (mecholyll)². This drug has been studied by a number of workers, most of them noting that their results in general were uniform and similar. The effect of mecholyll upon the gastro-intestinal tract has, of course, been investigated (4) (5). It is the purpose of this paper to add to this present literature a study on the effect of this drug and its nullification by atropine on the colon of man.

METHOD

In the course of a study by one of us (Schube) of the gastro-intestinal tract in

cases having abnormal mental states, it was observed that in the well-delineated cases of dementia præcox there was frequently a decrease in the tonus and the motility of the colon which resulted in a delayed emptying time. It was felt that this type of colon was the most suitable upon which to observe the effects of mecholyll.

General Controls—To control the study, a group of 48 cases of dementia præcox was used. These were selected at random from the available hospital population, the only criteria being the specificity of diagnosis.

Specific Controls—Each case of dementia præcox selected for the mecholyll study was used as a control on itself and on the entire mecholyll group.

Each individual used in the study received a cleansing enema and two hours later a barium enema. This latter was followed under the fluoroscope and the barium allowed to run in until the colon was filled. In the control studies the tonus and motility, as well as the rate of emptying of the colon, were followed on successive days under the fluoroscope to complete emptying. In the 12 cases receiving mecholyll, this drug was administered after the colon had been filled with barium. The action of the drug was then followed by fluoroscopy and by x-ray films at approximately 5-, 10-, 20-minute, 1- and 24-hour intervals. In the five cases receiving mecholyll and atropine the action of the mecholyll was followed at 5-, 10-, and 20-minute intervals, the atropine was then administered and followed at 5-, 10-, and 20-minute and 24-hour intervals.

In all instances the dosage of mecholyll was 30 mg., and of atropine sulphate $\frac{1}{100}$ gr. All drugs were given subcutaneously in the region of the deltoid muscle.

¹ Read by title before the Radiological Society of North America at the Twenty second Annual Meeting at Cincinnati, Nov. 30-Dec. 4, 1936.

² We are indebted to Merck and Co. for the mecholyll used in this work.

Emptying time, six days *Mecholyl* 30 mg, five minutes, increased number of haustrations in transverse and descending

patent, irregular and deep haustral markings in transverse and descending colon, 10 minutes, same, 20 minutes, marked

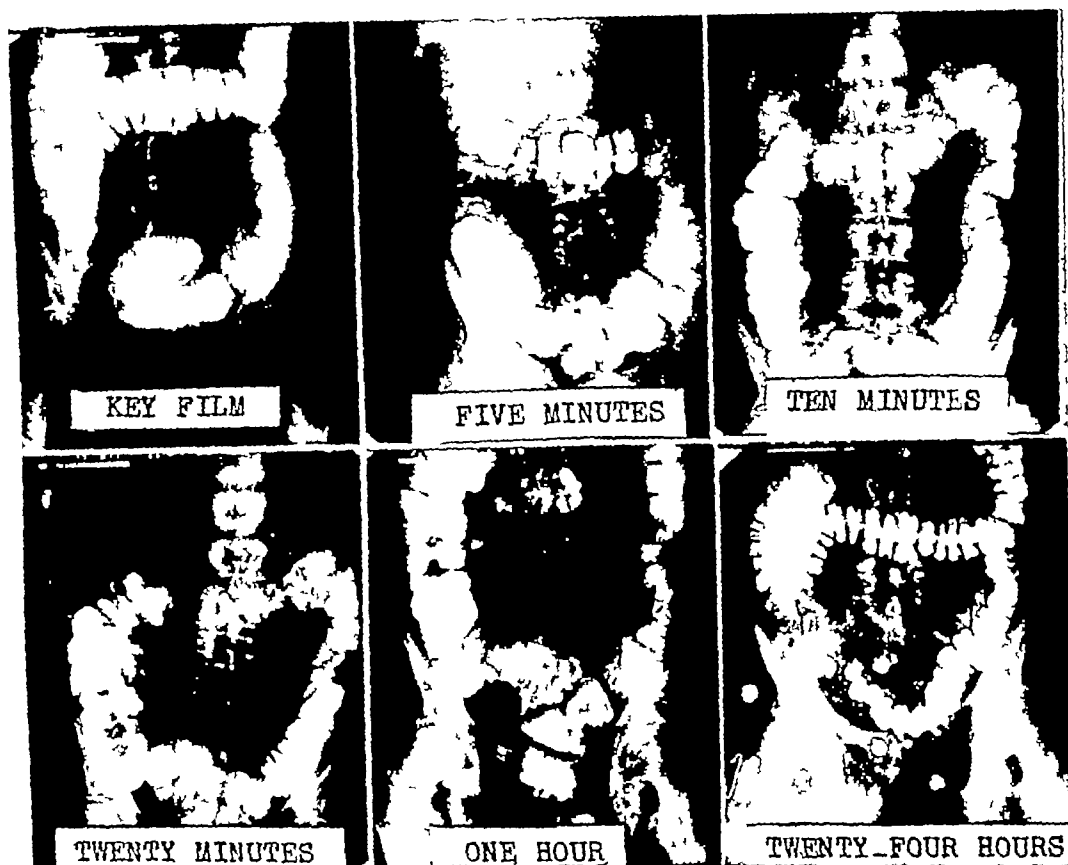


Fig 2 Case 2 The key film shows an atonic distended colon before the administration of mecholyl After the administration of the drug there is a marked increase in the tonus and the haustrations become deeper and more numerous Areas of spasm are visible on the ten minute and subsequent films At 24 hours, the colon is still hypertonic and contracted

colon and in sigmoid, 10 minutes, same, 20 minutes, spasm in transverse and descending colon and sigmoid, one hour, evacuation, decrease in long and transverse axes of large bowel, spasm of cecum, ascending, transverse and descending colon, rectum contracted 24 hours, evacuation, haustrations marked and irregular, entire colon spastic

Case 7 White male, aged 25 years *Control* Colon capacity 2,000 c c Tonus and motility decreased Emptying time, six days *Mecholyl* 30 mg, five minutes, evacuation, cecum smaller, ileo-cecal valve

spasm of descending and sigmoid colon, one hour, evacuation, marked spasticity and irregularity of ascending and transverse colon, cecum small, 24 hours, entire colon empty

Mecholyl and Atropine—Case 10 White male, aged 33 years *Control* Colon capacity 2,000 c c, 1,950 c c retained Tonus and motility decreased Emptying time, eight days *Mecholyl* 30 mg, five minutes, haustrations marked particularly in descending and ascending colon, rectum appears smaller, 10 minutes, long and transverse axes of entire colon have de-

The following are several case reports selected from the group upon which this study is based

Case 2 White male, aged 27 years
Control Colon capacity 2,000 cc, retained
Tonus normal, motility de-

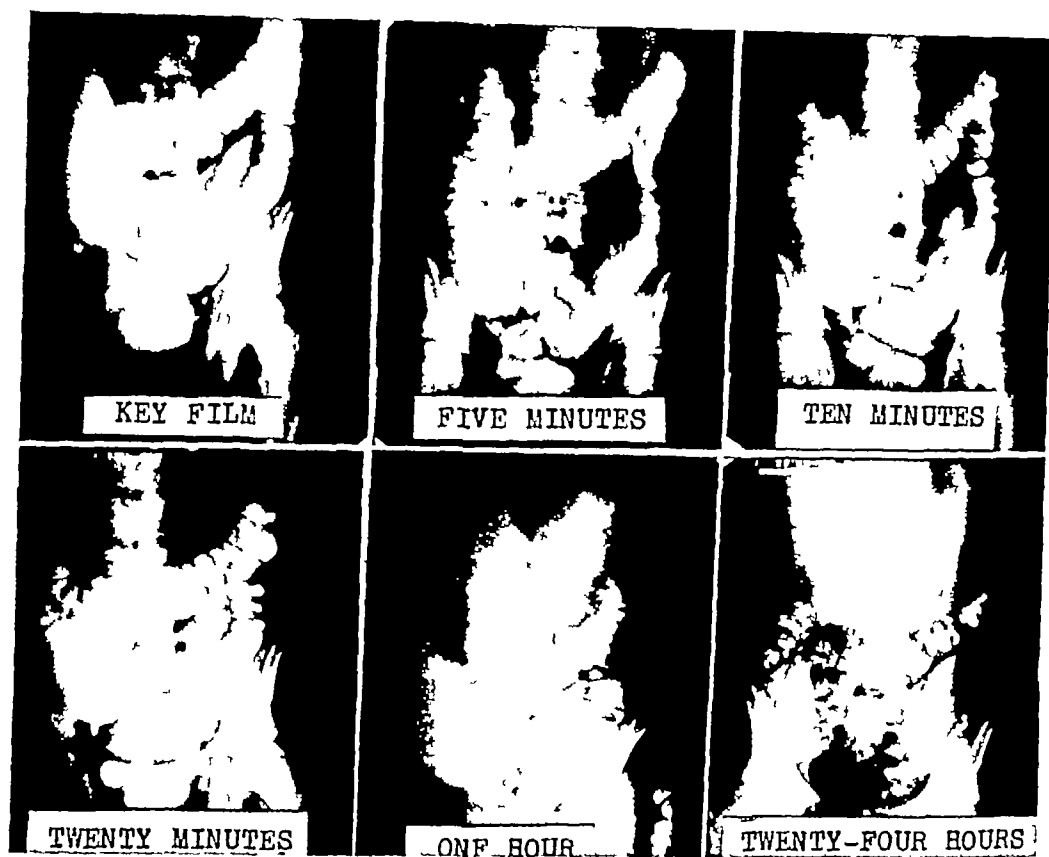


Fig 1 Case 1 The key film shows the colon atonic and dilated, with shallow haustrations. The films after the administration of 30 mg. of mecholyl show a marked increase in the tonus, the haustral markings are increased in number and depth. At 24 hours the colon is almost entirely empty and spastic.

PROTOCOLS

Mecholyl—Case 1 White male, aged 25 years Control Colon capacity 2,000 cc, retained Motility and tonus decreased Emptying time, 12 days *Mecholyl* 30 mg, five minutes, marked increase in tonus throughout colon, 10 minutes, tonus more marked and motility pronounced, 20 minutes, evacuation, haustrations are marked throughout, one hour, evacuation, shortening of long and transverse axes of colon, 24 hours, evacuation, haustrations are narrow and show irregularities in size, practically no barium in bowel

creased Emptying time, four days *Mecholyl* 30 mg, five minutes marked increase in tonus, haustrations irregular, decrease in size of rectum, 10 minutes, increased tonus, evacuation, shortening longitudinal axis of colon, 20 minutes, marked spasticity transverse colon, irregularity of cecum, rectum full, one hour, tonus of cecum increased, spasticity of transverse and descending colon, 24 hours, marked spasticity throughout colon, long axis has returned to original

Case 6 White male, aged 27 years Control Colon capacity 2,000 cc, retained Tonus normal, motility decreased

DISCUSSION

The observations presented in this paper lead to two specific conclusions, *ie*, (1)

and motility This speed and violence of change lasted several hours with a gradually progressive diminution, but the in-

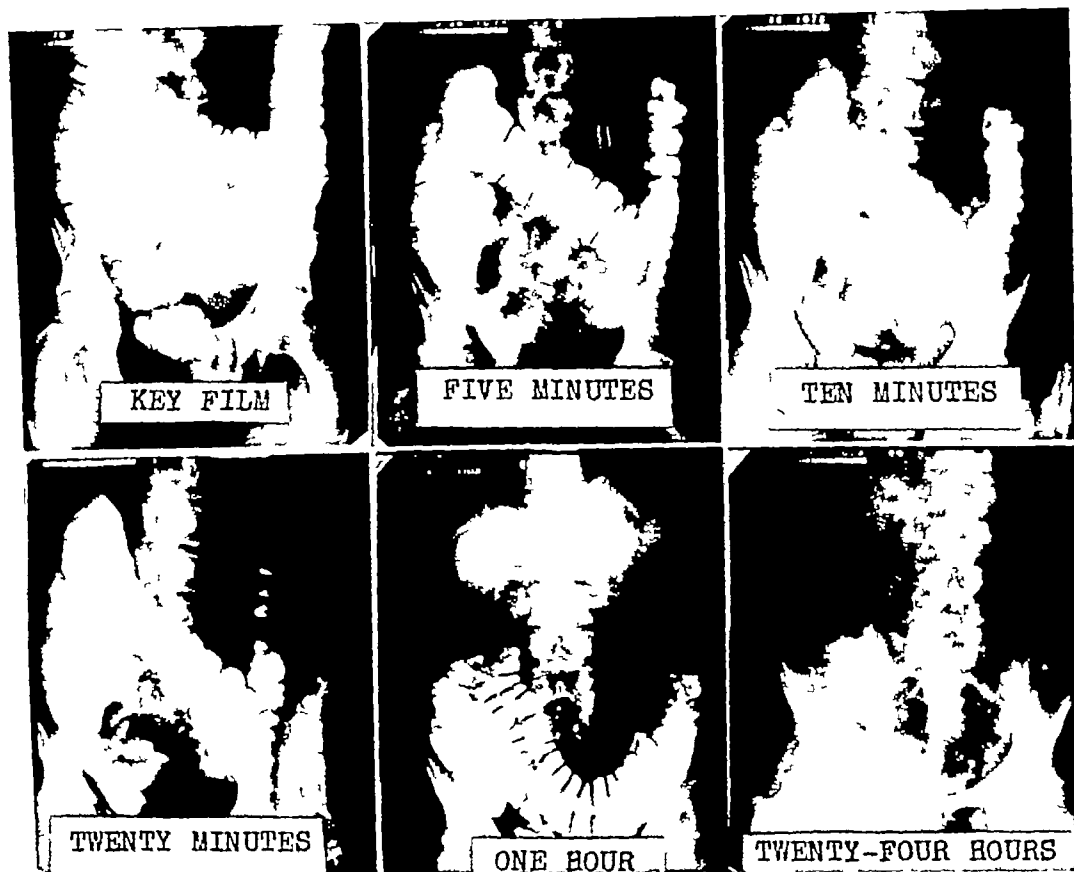


Fig 4 Case 7 The colon before giving the mecholyl (key film) is markedly dilated and atonic After the injection of the drug, there is a marked increase in tone The '24-hour' film shows complete evacuation, prior to the injection, it required six days to empty the colon

mecholyl increases the tonus of the colon to spasticity and at the same time increases the motility of the colon resulting in increased evacuation rate, *ie*, decreased emptying time, (2) atropine banishes any effects produced by mecholyl

The tonus and, or, motility of the colon was not produced in an orderly or progressive manner The onset of the action was rapid and at times violent It attacked the entire colon so that while some part of it always appeared spastic, another showed rapidly fluctuating movement while another appeared entirely normal In a moment this entire picture was changed but always on the side of increased tonus

crease in tonus continued for at least 24 hours In this respect the length of action of mecholyl on the colon was different from its other actions, for the rise in pulse rate, drop in blood pressure, salivation, rhinorrhea, lacrimation, flushing, and sweating were of short duration The reason for this difference is at the present unknown

The mechanism of the action of the mecholyl upon the colon is in most all probability that of all of the cholines, *ie*, directly on the muscle cells

Clinically, the drug is at the present of doubtful value in the treatment of atonic colons because of the unpleasant side reactions in all dosages wherein it has been used

creased with increase in haustral markings, sigmoid spastic, rectum small, 20 minutes, entire colon spastic, much movement

definite increase in motility, at times the colon in portions seems to disappear, 10 minutes, cecum and rectum smaller, ileo-



Fig 3 Case 6 The key film shows the colon markedly atonic with almost complete absence of haustral markings, it required six days to empty the colon After the injection of mechohyl, the colon shows a prompt and marked increase in tonus The colon is practically empty 24 hours after the injection

throughout, there is a definite desire to evacuate *Atropine sulphate* $\frac{1}{100}$ gr, five minutes, desire to evacuate has disappeared, cecum larger, rectum larger, 10 minutes, transverse colon definitely wider than before, 20 minutes, relaxation of entire bowel, no spasticity noted, 24 hours, much barium in colon, no evacuation

Case 11 White male, aged 36 years
Control Colon capacity 2,000 c c, 1,800 c c retained Tonus and motility normal Emptying time, four days *Mecholyl* 30 mg, five minutes, tonus of entire colon increased with definite decrease in transverse diameter, haustrations increased,

cecal valve patent, haustrations in ascending, transverse and descending colon marked, sigmoid spastic, 20 minutes, long and transverse diameters of colon decreased, desire to evacuate *Atropine sulphate* $\frac{1}{100}$ gr, five minutes, desire to evacuate less pronounced, cecum larger, 10 minutes, no desire to evacuate, rectum larger, haustrations less marked, long axis increased over original, 20 minutes, tonus has returned to normal although there are a few increased markings in transverse colon and splenic flexure, rectum and cecum dilated, 24 hours, colon has returned to its control state, much barium remains

EXCRETORY UROGRAPHY¹

By JOSEPH B. PRIESTLEY, M.D., F.R.C.S., *Des Moines, Iowa*

WITHIN recent years the advent of excretory urography has added valuable diagnostic procedure to the armamentarium of urologic diagnosis, which may occasionally supplant cystoscopy in the hands of one intimately acquainted with urologic pathology. However, for the vast majority of patients, cystoscopy, with or without retrograde pyelography, remains the most accurate and dependable diagnostic procedure. As in all diagnostic examinations, definite indications for excretory urography exist, certain technics add to efficiency, and certain pitfalls constantly lurk for the inexperienced.

I wish to discuss briefly the preparation of the patient, the indications, and then mention some of the limitations and dangers in interpretation, using a few illustrative cases as the basis of my remarks. Pyelographic interpretations will be discussed by Dr. Gilkes and Dr. Kerr in the next paper. I shall omit special reference to children.

TECHNIC

To secure the maximum amount of information by excretory urography, roentgenograms free of gas shadows are essential. Therefore, from 30 to 45 c.c. of castor oil should replace the evening meal before the examination. In the morning, several enemas should be given and a light breakfast allowed. Restriction of fluid intake for several hours may increase contrast medium concentration. Some feel that a compression bag retards the escape of the medium down the ureter and so aids in concentration. Frequently it will tend to displace the colon so that gaseous shadows will not overlap the renal area. Recently, the intramuscular in-

jection of pitressin 20 minutes before examination has been advocated. The urologist must be intimately acquainted with the patient's general condition in order to avoid certain contra-indications to pitressin, such as hypertension, intestinal obstruction, etc. My experience with pitressin to evacuate gas from the bowel has been limited. I do not use it routinely. Before administration of the medium, a roentgenogram of the kidneys, ureters, and bladder should be taken so that any faint shadows may be perceived before possible obscurity by the medium, and to determine before administration of the medium that preparation has been satisfactory. The medium ordinarily should be given in the median basilic vein, with moderate slowness. The patient neither sits up nor takes fluids without being so ordered. The first exposure should be made after an interval of five minutes, the next after 15 minutes. By examining the first roentgenogram before the second is taken, one may determine whether the second should be exposed earlier or later than the routine interval, depending upon the quantity of the medium in the bladder and the degree of renal visualization. In the presence of hydronephrosis or apparently non-functioning kidneys, one or more delayed roentgenograms ranging in time from one-half to two hours following the injection of the medium may give additional information. I have used neopax almost exclusively, and in my experience, which includes a large number of cases, local gangrene has never occurred. Moderately severe phlebitis occurred twice, but it subsided without complications under adequate treatment. The injection, especially when a small vein is used, may be accompanied by transient pain in the arm and shoulder and often a metallic taste in the mouth, but no severe systemic

¹ Presented before the Radiological Society of North America at the Twenty-second Annual Meeting at Cincinnati, Nov. 30-Dec. 4, 1936.

by us to obtain therapeutic benefit. If the side reactions such as sweating, flushing, etc., could be eliminated by some subsequent modification of the drug, it is very possible that it could be used advantageously in the stimulation of the atonic colon.

SUMMARY

1 A study of the effect of mecholyl upon the tonus and motility of the colon is presented.

2 In every case the tonus and motility were definitely increased.

3 The effects of mecholyl upon the colon were abolished rapidly by atropine.

4 Mecholyl is of possible therapeutic value in the atonic colon.

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Cystoscopy was not necessary, the other kidney being well visualized and appearing normal

less or absent kidney However, a delayed film will usually reveal the true nature of the condition



Fig 1 Roentgenograms in the case of a man referred with the diagnosis of mesenteric thrombosis presenting abdominal pain distention, and vomiting A Plain roentgenogram showing shadow in region of left upper ureter B, Excretory urogram showing caliectasis on same side above shadow Left uretero-lithotomy recovery

III *Hydronephrosis* — Excretory urography is valuable in diagnosing hydronephrosis Case 5 was a man 28 years of age, who had diabetes His physician repeatedly found a small number of pus cells in the urine, but the patient complained of no urinary symptoms These few cells were thought to be of no particular importance in the absence of symptoms, but an excretory urogram was advised (Fig 2) You see a large functionless hydronephrotic kidney A nephrectomy was performed because renal damage had proceeded too far for any conservative operation The patient's convalescence was uneventful Since then his urine has been examined repeatedly, and on one occasion mandelic acid therapy instituted because of persisting infection in the urinary tract In hydronephrosis, roentgenograms taken within 20 minutes, and sometimes even longer, may show no medium, thus giving the impression of a function-

IV *Mass in the Abdomen* — Frequently a clinician finds himself confronted with an abdominal mass of somewhat uncertain etiology Case 6 was a patient with a mass of undetermined nature in the region of the left kidney An excretory urogram was advised to establish a definite diagnosis As you see, the left kidney appears normal The mass later proved to be a primary sarcoma of the spleen Many horseshoe kidneys present a mass in the abdomen, often in the region of the navel Occasionally an ectopic kidney presents a mass in the iliac fossa or elsewhere When urologic possibilities are kept in mind for these unusual abdominal masses, an excretory urogram often points out the correct diagnosis even though retrograde cystoscopy may subsequently be necessary

V *Vague abdominal complaints* may have a genito-urinary origin Occasionally renal stone manifests itself only by

reaction There are few contra-indications to the administration of neo-*iopax*. More recently, I have employed diodrast, but my personal experience has not been adequate to draw conclusions. I have been impressed by the fact that the pain during the injection of diodrast seems less and the visualization appears equal to that obtained with neo-*iopax*.

INDICATIONS

The indications for excretory urography, generally speaking, are modified considerably by individual circumstances. I shall consider these indications, fully aware of the fact that many cases may also require retrograde pyelography and cystoscopy to establish the correct diagnosis and to obtain the necessary information. Eight main groups of cases will be discussed.

I *Suspected renal or ureteral lithiasis* constitutes the most frequent indication for excretory urography.

Case 1 This patient, when seen, was suffering frequent attacks of renal colic, though his general condition otherwise appeared good. The plain roentgenogram shows a small shadow in the region of the upper ureter. The excretory urogram, taken 45 minutes after the administration of neo-*iopax*, discloses the same shadow, somewhat intensified by opaque medium, with pronounced urosthesis above involving both the pelvis and calices. Medium in the distal ureter indicates incomplete obstruction. The visualization of the other kidney indicates no abnormality. Consequently ureterolithotomy was performed without a cystoscopic examination. His convalescence was uneventful.

Case 2 In the case of an elderly man suffering from severe renal colic, there were seen three shadows on the plain roentgenogram. The excretory urogram disclosed two shadows in the lower major calix, with some caliectasis and pyelectasis which confirmed our suspicion that the remaining shadow was in the upper ureter. The diagnosis was established and treatment decided upon without re-

sorting to retrograde pyelography. The patient was scheduled for ureterolithotomy. A roentgenogram taken in the morning before operation indicated that the stone had moved down to the middle of the ureter, and the operation was, therefore, abandoned. Instead, the ureteral stone was successfully removed by transureteral manipulation.

II *Acute Abdomen*—One sees two types of acute abdominal conditions in which excretory urography may be of distinct diagnostic aid by indicating whether or not urologic pathology explains the symptom.

(a) Red blood cells in a catheterized specimen of urine from a patient suspected of appendicitis should arouse suspicion. The symptoms of ureteral stone and appendicitis occasionally may be confusing. Case 3 represents such a patient. The diagnosis was confused by the discovery of red blood cells in a catheterized specimen of urine. An excretory urogram was made immediately. The plain roentgenogram shows this rounded shadow in the ureteral area. A urogram conclusively excludes the shadow because a normal urinary tract appears on the right side. Accordingly, I performed an appendectomy and removed a very acutely inflamed appendix. I wish to emphasize the fact that microscopic hematuria accompanying acute appendicitis occurs so rarely that the diagnosis of appendicitis with hematuria must always be looked upon with suspicion.

(b) At times an acute abdominal condition is associated with generalized abdominal pain or marked distention. Case 4 represents a patient whose condition was diagnosed as mesenteric thrombosis by the family physician (Figs 1-A and 1-B). Close questioning elicited information suggesting renal colic at the onset. Here you see a shadow in the upper ureteral area which a delayed excretory urogram indicates to be a ureteral stone. Several days after the reflex abdominal ileus improved, this stone was removed, with complete recovery of the patient.

mittent chills and fever I was unable to pass a catheter up the ureter, and, therefore, resorted to an excretory urogram for estimating the renal damage. You see (Fig 4) a moderate hydronephrosis resulting from a post-operative ureteral obstruction, which later demanded nephrectomy.

(2) *Post-operative Hydronephrosis* — For moderate degrees of hydronephrosis various types of conservative operations are performed on the renal pelvis without sacrificing the kidney, such as the division of obstructing anomalous vessels, plastic procedures to decrease the size of the renal pelvis, and operations to place the uretero-pelvic juncture in a dependent position in the renal pelvis. The advisability of a post-operative check-up several months later arises, to determine one's result and the ability of the pelvis to empty. An excretory urogram serves this purpose well since it demonstrates varying degrees of hydronephrosis.

3 *Solitary Kidney* — Not infrequently we encounter patients who have had a previous nephrectomy and now complain of symptoms referable to the remaining kidney. Under present conditions, retrograde pyelography seldom results in renal damage or reflex anuria, however, such things do occur occasionally. Consequently, in the presence of a solitary kidney we employ excretory urography, resorting to retrograde pyelography only in unusual instances.

(c) *Epitheliomatous Bladder* — As a general rule, all patients with vesical tumors should have a biopsy made. When the biopsy reveals a squamous-cell epithelioma, one must then exclude the kidneys as a primary focus of the epithelioma. Excretory urography frequently can be employed very satisfactorily for this purpose.

(d) *Ruptured Kidney* — Excretory urography for the diagnosis of ruptured kidney has been advocated. My personal experience with this has been too meager to warrant my drawing conclusions. It

will, however, demonstrate the presence of a kidney on the uninjured side.

(e) *Suspected Congenital Anomalies* — Occasionally a retrograde pyelogram shows the renal pelvis confined to the upper or lower half of the renal shadow, which



Fig 4 Excretory urogram in the case of a patient who underwent hysterectomy 12 years previously suffering left renal distress at intervals since. Note left hydronephrosis and ureterectasis. Ureteral catheter met an impassable obstruction in lower left ureter. Ureteral stricture resulting from surgical injury required nephrectomy gallstone.

arouses the suspicion of a duplicated pelvis. At times an excretory urogram may be of considerable aid in demonstrating the other pelvis. Frequently another retrograde pyelogram will be necessary. Since the advent of excretory urography, many duplications and anomalies have been discovered, such would have been unquestionably overlooked without it. However, this is in the main of anatomic interest mostly, but it does make us more alert to the possibility of pathology in various urologic anomalies.

(f) *Renal Tuberculosis* — At times the diagnosis of renal tuberculosis can be established by an excretory urogram, coupled with finding tubercle bacilli in the urine (Fig 5). At other times

reflex gastro-intestinal symptoms. Early stages of renal insufficiency from various causes may excite similar symptoms. Of-

with certainty in other cases one may desire more definite information. Usually the excretory urogram will show extensive



Fig 2 Excretory urogram in the case of a diabetic male, aged 24 years with no urinary symptoms except persistent pyuria. Note large left hydronephrosis and right duplicated kidney. Left nephrectomy recovery.



Fig 3 Excretory urogram confirming the diagnosis of polycystic kidneys. Note the pronounced bilateral deformity.

ten the urologic symptoms of such patients are so meager that the physician hesitates to advise cystoscopy. However, an excretory urogram may be made to exclude the urinary tract. If one obtains positive evidence, then cystoscopy may be indicated.

VI The Exclusion of Shadows—Occasionally during the roentgenologic examination of patients, shadows appear in the region of the kidneys or ureters. Although symptoms of calculus may be absent, the advisability of excluding the shadows often arises. An excretory urogram under such circumstances frequently excludes such shadows, and so one avoids cystoscopy. If positive, cystoscopy may or may not be indicated later.

VII Polycystic Kidney—In many patients with polycystic kidneys, palpation alone may establish the diagnosis

bilateral defects which clinch the diagnosis without further ado (Fig 3).

VIII Certain specific urologic conditions—Urologists treat many patients for (a) prostatitis. When a prostatic infection exists, the second glass specimen of urine may contain a few pus cells, coming either from the prostate or from the kidneys. In certain cases of this type, an excretory urogram may be used to great advantage to exclude possible renal pathology.

(b) An excretory urogram proves of considerable value in certain post-operative conditions of the kidneys and ureters, as follows:

(1) Impassable Ureteral Stricture—

Case 7 This patient had had a hysterectomy performed some years before coming to me. Following the operation, urine drained from the wound for several months. She then developed pain in the renal area, with inter-

THE ROENTGEN DIAGNOSIS OF LESIONS OF THE UPPER URINARY TRACT¹

OBSERVATIONS ON 432 PATIENTS HAVING RETROGRADE PYELOGRAMS

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From the Department of Radiology, State University of Iowa College of Medicine

IN the roentgen diagnosis of lesions of the upper urinary tract, clinical and laboratory findings admittedly should be given full consideration. In practice, however, it at times is expedient to give a preliminary report of the radiographic examination before all data become available. It is, therefore, necessary that the radiologist be thoroughly familiar with the appearance of lesions likely to be encountered. Our purpose is to review the radiographic appearance of kidney lesions as revealed by retrograde pyelograms.

For this study we have selected 432 consecutive cases in which a pathologic diagnosis was made. These diagnoses were arrived at only after correlation of the clinical, laboratory, and radiographic examinations. Only adult patients on whom retrograde pyelograms were made are included in this series.

INFECTION

Infection heads the list in frequency of all lesions of the upper urinary tract. A diagnosis of pyelitis, pyelonephritis, or pyonephrosis was made 95 times in our series of 432 cases. In addition it sometimes complicates urinary calculi and hydronephrosis.

The age incidence of these patients varied from 18 to 66 years, the average being 40.7 years. It was found in women twice as often as in men and bilateral involvement was nearly twice as frequent as unilateral involvement.

In the mild or acute types of infection there may be no detectable changes in the

pyelogram and it is necessary to make the diagnosis entirely by clinical and laboratory methods.

The more severe or longer standing infections present definite changes in the pyelogram. The first are noted in the calices, which lose their sharp outline and become dilated and clubbed. Infection also causes dilatation of the pelvis, which usually is not as marked as that due to obstruction. In long-standing or recurrent infection, the minor calices become elongated and show narrowed necks, the result of scarring. The calyx then is cone-shaped and its appearance is likened to that of a "dunce cap." The scarring also causes irregularity of the pelvis which, however, is not as marked with pyogenic infection as with tuberculosis (Fig. 1). Clubbing of some calices with narrowing of others is frequently present on the same pyelogram. Dilatation of the ureter often accompanies infection and was present in nearly one-half of our cases.

PERINEPHRITIC ABSCESS

In this series there were eight cases of perinephritic abscess. Two occurred in conjunction with a pyonephrosis. As mentioned elsewhere, one followed traumatic rupture of the kidney, three were found complicating renal calculi, two ureteral calculi.

With perinephritic abscess, there is likely to be a loss of the psoas shadow on the involved side, with a scoliosis of the lumbar spine. The convexity of the curve is away from the involved side. There are no direct pyelographic changes unless, as sometimes occurs, the abscess communicates with the kidney pelvis. In such an event the abscess cavity becomes

¹ Read before the Radiological Society of North America at the Twenty-second Annual Meeting at Cincinnati, Nov. 30-Dec. 4, 1936.

one may diagnose a renal tumor from an excretory urogram alone. However, these two types of cases do not pre-

lent cystogram will be obtained, which may give considerable information. A primary cystogram should seldom be made

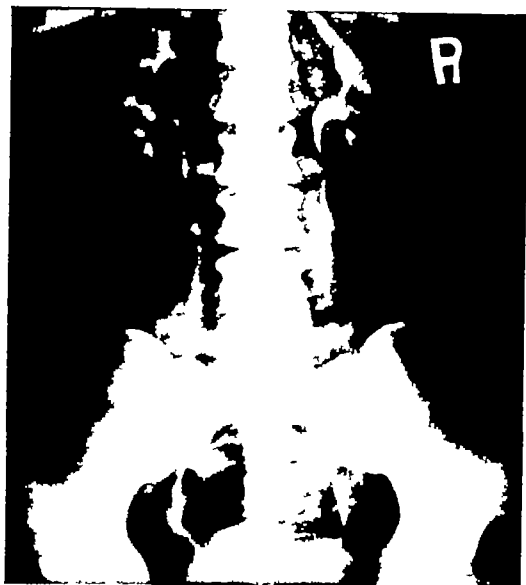


Fig 5 Excretory urogram in the case of a patient suffering recurrent attacks of dysuria for three years. The left pyelogram strongly suggests renal tuberculosis. Tubercle bacilli were recovered from the bladder urine. Microscopic diagnosis of left kidney after removal was renal tuberculosis.

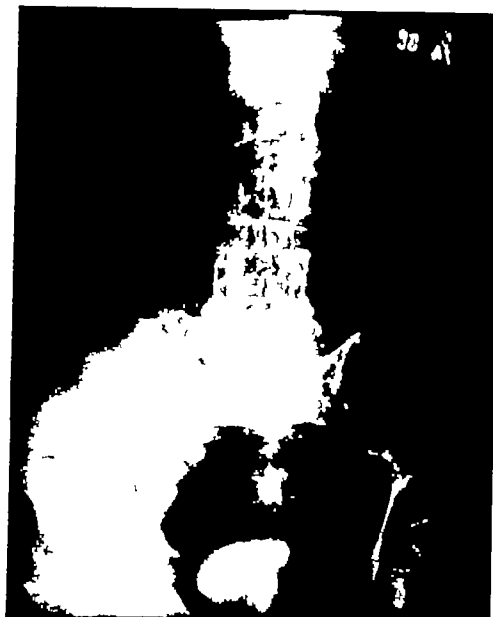


Fig 6 Excretory urogram in the case of a male aged 63 years suffering gross hematuria. Excretory cystogram discloses defect suggesting bladder tumor. Biopsy obtained transurethraally revealed Grade III carcinoma.

sent indications for an excretory urogram and should not be considered among this group. The same can be said for certain other rare conditions upon which I will not touch.

DISCUSSION

To diagnose excretory urograms accurately, one must possess a sound knowledge of retrograde pyelographic interpretation. The absence of visualization, such as is often caused by stone, anomalies, etc., must not be interpreted as indicative of permanent renal damage. Incomplete filling of the normal renal pelvis should not be mistaken for disease. Excretory pyelograms should be employed only rarely for the diagnosis of inflammatory renal lesions.

Often when examining a patient by means of excretory urography, an excel-

lent cystogram will be obtained, which may give considerable information. A primary cystogram should seldom be made in this manner. The patient in Case 8 complained of gross hematuria. The excretory cystogram showed a bladder defect suggestive of neoplasm (Fig 6). This diagnosis was confirmed cystoscopically, and necessary treatment instituted. Not infrequently when an excretory urogram is made upon a patient with prostatic hypertrophy, one observes a marked intravesical enlargement of the prostate, shown by the excretory cystogram.

CONCLUSIONS

Excretory urography constitutes a valuable contribution to urologic diagnosis, but only occasionally supplants retrograde pyelography. Serious errors may occur in interpretations when the limitations are not realized or the indications too widely broadened.

1418 Des Moines Bldg



Fig 3



Fig 4

Fig 3 Autonephrectomy from advanced tuberculosis In this type, the tubercles do not empty into the pelvis but become calcified—the so-called "putty kidney"

Fig 4 Bilateral hydronephrosis Note uniform smooth dilatation of pelves, calices, and ureters The cupping of the minor calices has been lost

tion, a marked irregularity of the pelvic outline

In some instances the entire kidney is replaced by large caseous tubercles which have failed to drain into the kidney pelvis. These then become partially calcified so that the individual tubercles are well outlined on the radiographic film (Fig 3). The so-called "autonephrectomy" is the result of this type of tuberculous infection. When such a kidney is sectioned, it is of putty-like consistency and shows complete replacement of the kidney parenchyma by caseating tubercles.

HYDRONEPHROSIS

Next to infection, hydronephrosis is the most frequent lesion of the upper urinary tract and was found in 79 of our patients. It occurs in varying degrees but is much more common as a mild form. In only six of our cases was the disease advanced, while in 18 it was considered moderately advanced. Women were affected in more than two-thirds of our cases. The left kidney alone was involved in only about 10 per cent, in more than one-third it was bilateral, while the right kidney alone was affected in more than 50 per cent of the cases.

The condition begins as a mild dilatation of the kidney pelvis and may early show

some blunting of the minor calices, although occasionally one finds a moderate degree of involvement of the major and minor calices without accompanying pelvic enlargement. As the disease progresses, the minor calices become more globose and expand at the expense of the parenchyma (Fig 4). Ureteral dilatation is a concomitant of hydronephrosis when the obstruction is low and was found in more than one-half of our cases.

The presence or absence of infection of the hydronephrosis cannot be determined radiologically even though the infection be marked.

PTOSIS

Movable or ptotic kidney is not uncommon and was diagnosed 18 times in our 432 cases. It is usually accompanied by a mild degree of hydronephrosis, although in five of the 18 cases there was no dilatation of the pelvis. The appearance of the hydronephrosis does not distinguish it from that without ptosis. The ptotic kidney should not be confused with the congenitally unascended kidney. In the former the ureter is long and redundant when the kidney is displaced downward, while in the latter the ureter is relatively short and straight, and the kidney shows a lack of normal rotation.



Fig 1

A

Fig 2

B

Fig 1 Chronic bilateral pyelonephritis. Note marked narrowing of major calices from scarring, clubbing of minor calices and extensive kidney damage.

Fig 2-A Early tuberculosis. Abscess cavity in upper pole outlined by opaque medium. Upper minor calyx shows irregular outline. There is also extravasation of the opaque medium into parenchyma.

Fig 2-B Far advanced tuberculosis. Note marked irregularity of pelvis and calices and destruction of kidney substance.

outlined by the opaque medium, a finding which is characteristic of perinephritic abscess.

TUBERCULOSIS

A diagnosis of renal tuberculosis was made in 20 of the cases of this series, 14 occurring in men and six in women. The ages of the patients ranged from 20 to 54 years, the average age being 38 years. One patient showed a congenital anomaly, a duplication of the kidney pelvis and ureter on one side. Both kidneys, however, were involved with tuberculosis.

Calcification is frequently seen in renal tuberculosis and was present in nearly one-half of our cases. This calcification usually appears as a diffuse mottling and does not tend to occur in dense solid masses, therefore is not readily confused with calculi.

It was also observed that extravasation of the opaque medium as radiating striæ extending into the kidney parenchyma frequently occurred, being present in over one-third of the cases. While we are aware that similar extravasation may occur in a normal kidney from too forceful an injection of opaque fluid, such observa-

tions are rarely encountered in routine pyelograms.

The pyelograms in renal tuberculosis show a fairly characteristic appearance. The earliest radiographic changes are observed in one or two minor calices when the usual smooth outline is replaced by a rough "moth-eaten" contour. When a tuberculous abscess has broken through into the pelvis and discharged its contents, it may become well outlined by opaque medium (Fig 2-A). If completely empty, these cavities may be smooth, but if some caseous debris remains the outline is irregular. In more advanced cases, the pelvis and calices are involved in their entirety and show marked irregularity of outline. In addition, there may be numerous abscesses within the kidney parenchyma communicating with the pelvis.

In advanced cases, secondary involvement of the ureter is common. This manifests itself as an irregular narrowing which may give partial or complete obstruction, resulting in a tuberculous pyonephrosis. In the pyelogram this is observed as a marked dilatation of the pelvis and calices, with destruction of the kidney substance (Fig 2-B). There is, in addi-



Fig 7

Fig 8

Fig 7-A Large oval calculus in upper ureter Known to have been present for one year

Fig 7-B Pyelogram seven months after removal shows remarkably few changes

Fig 8-A Hypernephroma demonstrating elongated, compressed, and displaced calices The tumor has not invaded the pelvis

Fig 8-B Papillary carcinoma of kidney pelvis showing irregular filling of pelvis with neoplastic tissue

ureteral calculi occurred together, there were 42 cases of this series in which ureteral calculi were present alone. In 40 instances a single stone was present on one side. Only one case showed a stone on each side and in only one instance were there multiple stones in one ureter.

Calculi occurred with nearly equal frequency in men and in women. The left side was involved over a third more often than the right.

These calculi are usually oval in shape, with the long axis of the stone lying in the long axis of the ureter. The most frequent site is at the lower end of the ureter near the ureteral opening into the bladder. They vary in size from a few millimeters to two or three centimeters in length. Usually they are of rather high calcium content and of fairly uniform density although some show definite laminations.

Some degree of ureteral dilatation is also frequently present and may be either above or below the calculus.

In the presence of ureteral stone, a large percentage of the pyelograms show pathologic changes—the result of obstruction, accompanying infection, or a combination of both.

The presence of a ureteral stone, however, does not necessarily mean that kidney

damage has occurred, as a very large calculus may be present with little or no evidence of kidney pathology (Fig 7). On the other hand, very definite changes may be produced by a rather small calculus.

Perinephritic abscess may be a complication and was present in two of our cases.

MALIGNANT NEOPLASMS

Malignant neoplasm was diagnosed in 24 cases, 15 times in men and nine in women. The patients' ages varied from 43 to 70 years, the average age being 56.4 years. The right side was involved as frequently as the left and no case was bilateral, although bilateral involvement has been known to occur. In nine of the 24 cases, a pathologic diagnosis was obtained. Following Ewing's classification, these were diagnosed as follows:

- | | |
|--|---|
| (1) Adenocarcinoma | 4 |
| (2) Papillary carcinoma of the kidney pelvis | 1 |
| (3) Hypernephroma | 4 |

From a radiographic standpoint, malignant kidney tumors can conveniently be divided into two groups, those arising in the kidney parenchyma and those arising from the kidney pelvis.

In malignant neoplasms of the kidney

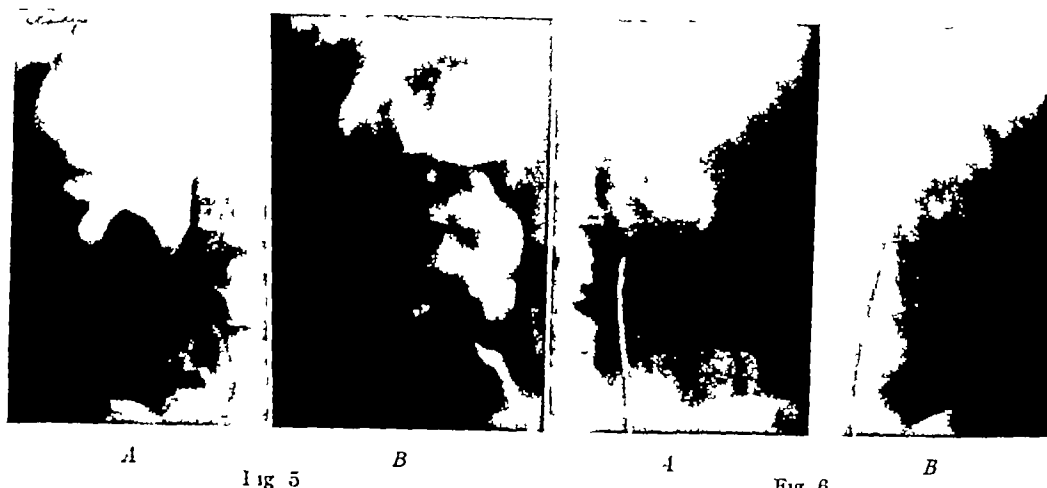


Fig 5 A Plain film showing branching calculus filling entire pelvis and calices
 Fig 5 B Pyelogram shows in addition a large abscess cavity in upper pole of kidney
 Fig 6 A Multiple faceted calculi
 Fig 6 B Single small stone in lower kidney pole Pyelogram was normal

RENAL CALCULUS

Stone in the kidney is a relatively frequent occurrence and was present in 73 cases of our series.² These stones may be single, multiple, or of the branching or so-called "staghorn" variety (Figs 5 and 6). Men are usually reported as being more frequently affected than women, but in our cases there were 40 women as against 33 men.

Single stones are most common. They show as uniform areas of calcification, varying in size from a few millimeters to several centimeters and are seen to lie within the kidney shadow. They are usually completely obscured by the injection of the pyelographic material, occasionally, however, a stone will contain no calcium. Such a calculus can then be demonstrated only on the opaque pyelogram as a shadow of negative density or a filling defect. The use of air as a pyelographic medium may clearly outline this type of stone.

Renal calculi are usually uniform in density, without visible laminations, and

rarely does one find faceted stones. Only one such case appears in our series.

In our 73 cases, there was involvement of 85 individual kidneys. The finding was more than twice as frequent on the left side as on the right, and while the single stone predominated, the staghorn type was present in almost 25 per cent of the cases. Ureteral calculi were seen as a complication of renal stones in a minority of cases (nine times), and when found were noted to be on the opposite side as frequently as on the side of the kidney stone.

In nearly every case of multiple or staghorn stone, kidney damage was observed, while with single calculus this occurred only in about half of the cases. This damage may show as an involvement of a single calyx with slight dilatation and roughening, or it may progress through varying stages until, because of gross stasis and infection, it becomes a marked pyonephrosis. This may then go on to the formation of a perinephritic abscess, which was present in three of our cases. The staghorn stone is most frequently associated with this advanced renal damage.

URETERAL CALCULUS

In addition to the nine patients previously mentioned, in which kidney and

² Ten cases of renal calculi occurring in this series have not been included in these figures because they were found together with other lesions which in themselves were considered primary, *i.e.*, three in duplex kidney, one in crossed ectopia, and six in hydronephrosis due to aberrant blood vessels.

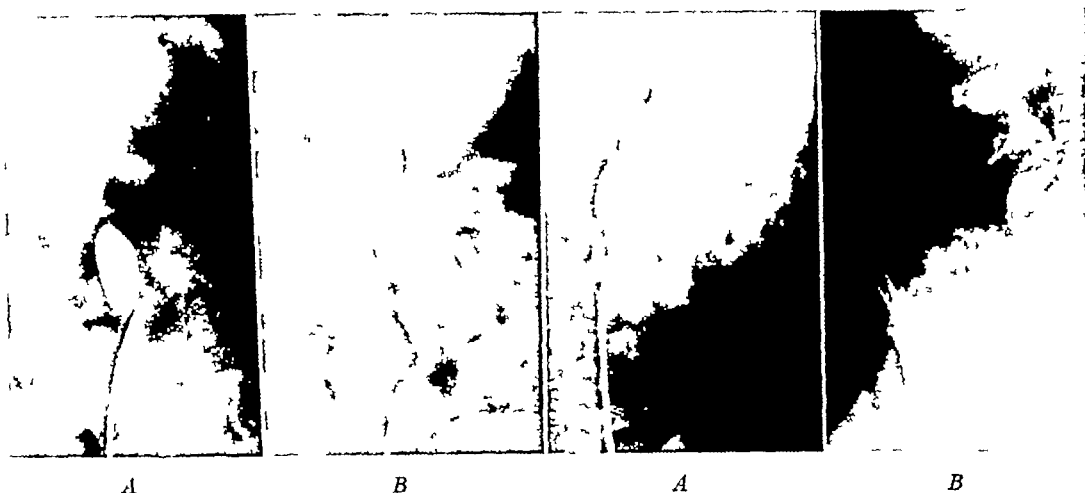


Fig 7

Fig 8

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ureteral calculi occurred together, there were 42 cases of this series in which ureteral calculi were present alone. In 40 instances a single stone was present on one side. Only one case showed a stone on each side and in only one instance were there multiple stones in one ureter.

Calculi occurred with nearly equal frequency in men and in women. The left side was involved over a third more often than the right.

These calculi are usually oval in shape, with the long axis of the stone lying in the long axis of the ureter. The most frequent site is at the lower end of the ureter near the ureteral opening into the bladder. They vary in size from a few millimeters to two or three centimeters in length. Usually they are of rather high calcium content and of fairly uniform density although some show definite laminations.

Some degree of ureteral dilatation is also frequently present and may be either above or below the calculus.

In the presence of ureteral stone, a large percentage of the pyelograms show pathologic changes—the result of obstruction, accompanying infection or a combination of both.

The presence of a ureteral stone however, does not necessarily mean that kidney

damage has occurred, as a very large calculus may be present with little or no evidence of kidney pathology (Fig 7). On the other hand, very definite changes may be produced by a rather small calculus.

Perinephritic abscess may be a complication and was present in two of our cases.

MALIGNANT NEOPLASMS

Malignant neoplasm was diagnosed in 24 cases, 15 times in men and nine in women. The patients' ages varied from 43 to 70 years, the average age being 56 1/2 years. The right side was involved as frequently as the left and no case was bilateral, although bilateral involvement has been known to occur. In nine of the 24 cases, a pathologic diagnosis was obtained. Following Ewing's classification, these were diagnosed as follows:

- | | |
|--|---|
| (1) Adenocarcinoma | 4 |
| (2) Papillary carcinoma of the kidney pelvis | 1 |
| (3) Hypernephroma | 4 |

From a radiographic standpoint, malignant kidney tumors can conveniently be divided into two groups, those arising in the kidney parenchyma and those arising from the kidney pelvis.

In malignant neoplasms of the kidney



Fig 9



Fig 10

Fig 9 Advanced hydronephrosis due to aberrant blood vessels Note rounding of all contours with extreme dilatation of pelvis

Fig 10 Duplex kidneys and ureters bilateral with moderate hydronephrosis and hydroureter This is the most common congenital anomaly

parenchyma the tumor mass itself may be visible on the radiograph, showing either as a distortion of outline or as an increase in density. In the larger tumors the kidney is likely to be obviously displaced from its normal position.

As the tumor grows it not only distorts the parenchymal outline but the kidney pelvis and calices as well (Fig 8-A). The calices are frequently elongated and narrowed by the general enlargement of the kidney, producing the so-called "spider leg" deformity. The calices may become displaced, compressed, or even completely occluded. Some malignancies of the parenchyma may invade the pelvis, producing filling defects in the pyelogram, in which instance it may be impossible to distinguish neoplasms of the parenchyma from those arising from the pelvis. Not infrequently the pelvis may become completely occluded so that it is impossible to obtain a pyelogram.

Diffuse and scattered calcification sometimes occurs within kidney malignancies. While not present in this series, calcification was observed three times in another series of 23 cases that we had opportunity to study.

Tumors arising from the epithelial lining of the kidney pelvis are usually papillary

and, therefore, cause an irregular filling defect in the pyelogram (Fig 8-B). There is no distortion of the pelvic outline until occlusion of some of the calices occurs, in which instance a localized hydronephrosis may develop. These tumors are prone to metastasize along the ureter with resulting obstruction. Radiographically, it may at times be impossible to differentiate tumors of the kidney pelvis from blood clots, non-opaque calculi, or masses of cellular debris.

Benign tumors of the kidney and kidney pelvis are not common and are rarely diagnosed except at operation or post-mortem examination.

CONGENITAL ANOMALIES

Hydronephrosis Due to Aberrant Blood Vessels—Aberrant blood vessels to the lower pole of the kidney, with constriction of the uretero-pelvic junction and hydronephrosis, were diagnosed in 38 of our 432 cases. Such constitute, therefore, a relatively common lesion.

The pyelographic changes are fairly characteristic. In mild types there is a squaring of the kidney pelvis noted, particularly at the uretero-pelvic junction, where the aberrant vessel crosses the ureter, causing it to be narrowed and fixed at the

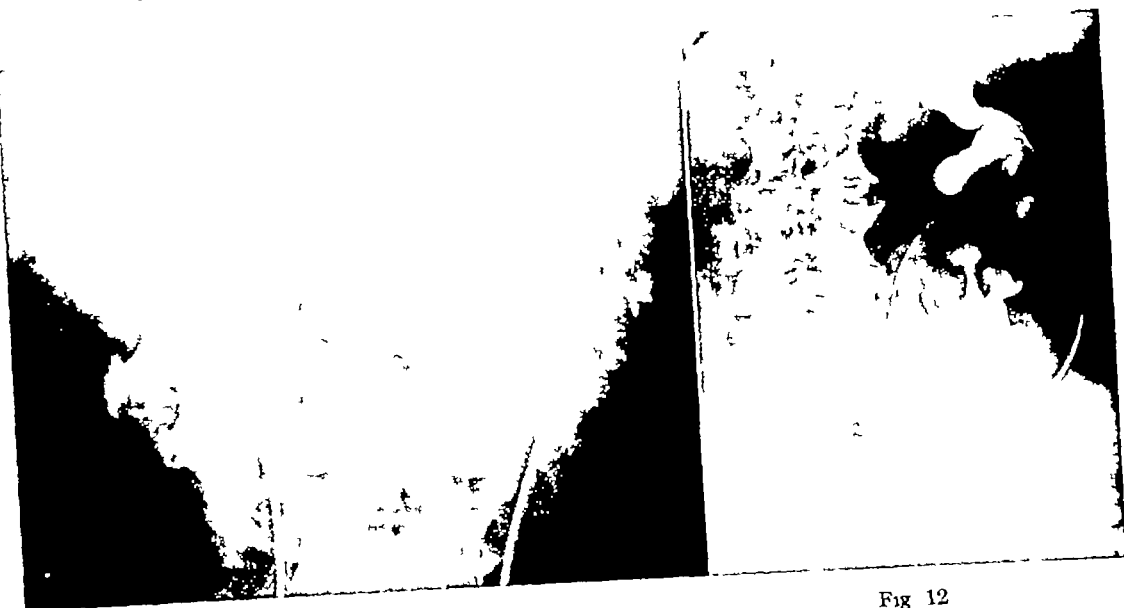


Fig 11

Fig 12

Fig 11 Horseshoe kidney
Fig 12 Crossed ectopia
ascent

Failure of complete rotation with fusion of the lower poles
Both kidneys on one side, show apparent fusion with incomplete rotation and

same level or slightly above the lower margin of the dilated pelvis. The medial and inferior borders of the kidney pelvis are then nearly at right-angles to each other instead of forming the inverted cone of the normal uretero-pelvic junction. As further dilatation of the pelvis occurs it overhangs the attachment of the ureter so that in advanced cases the uretero-pelvic junction lies several centimeters above the lower margin of the kidney pelvis. The calices take part in the general dilatation so that in more advanced cases the pelvis has a plump oval appearance, with dilated rounded calices (Fig 9). The outline is composed of gentle curves with an almost total lack of angles except at the attachment of the ureter, which is angled sharply over the aberrant vessel. This usually crosses in front although it may cross behind the ureter.

In cases with marked hydronephrosis, infection is frequently present. Six cases in this series were also complicated by calculi and one patient had a duplex kidney and ureter on the opposite side.

Anomalies of Form and Position—The most common congenital anomaly of the upper urinary tract is a reduplication of the kidney pelvis. This deformity ranges from

slight variations, in which the pelvis is bifid, to complete reduplication of the pelvis and ureters. Included in this series are only those cases showing complete reduplication of the pelvis, together with a partial or complete reduplication of the ureters. There were 22 patients in this group, six men and 16 women. The right side was involved ten times and the left nine. Three cases were bilateral (Fig 10).

If the ureteral catheter is introduced into the ureter leading to the upper pelvis, the diagnosis can usually be suspected from the small lily-like pelvis which, if the kidney outline is visible, is obviously too small for the size of the kidney. If the lower pelvis alone is visualized, this usually is of nearly normal size and appearance and the anomaly may be readily overlooked. Should both pelvis be visualized either by double catheterization or by reflux in a partially reduplicated ureter, the diagnosis is, of course, obvious.³

Horseshoe kidneys were present in four patients, three men and one woman. In good films a bridge of renal tissue can be seen extending across the spine from one

³ In addition to the 22 patients of this group one case was complicated by tuberculosis (qr) and one by hydronephrosis due to an aberrant blood vessel (qr) on the opposite side.



Fig 13 Polycystic kidneys. Marked elongation and separation of calices with sharp clear-cut outlines
 Fig 14 A Cellular debris. Opaque pyelogram shows mild hydronephrosis with ill defined filling defect
 Fig 14 B Air pyelogram shows mass of cellular debris which cannot be distinguished from a non-opaque calculus

kidney to the other, producing the horse-shoe shape from which this anomaly derives its name. The most characteristic feature, however, is seen on the pyelograms. These kidneys fail to rotate normally as they ascend from the pelvis during development, so that the calices remain posterior and are superimposed or lie to either side of the renal pelvis in the pyelogram instead of being located laterally as in normal kidneys (Fig 11).

An unascended and unrotated kidney was present in each of two patients, the other kidney occupying a normal position. These are distinguished from a ptosed kidney by the short ureter that is present, together with the disturbed directional relationship of the pelvis and calices, the latter being usually located posteriorly. With ptosis, the ureter is of normal length and when dropping occurs it becomes tortuous. There is also likely to be some rotation of the kidney so that the calices are inferior to the pelvis.

Crossed ectopia is a rare anomaly and was present in only one case (Fig 12), both kidneys lying on the left side, with the right kidney below the left and apparently fused to it. The ureter entered the bladder at its normal location but curved upward and to the left to reach the mal-positioned kidney.

Congenital absence of one kidney is also rare and is said to occur about once in every thousand individuals. It was present in only one patient in this series.

Kidney calculi were present in ten out of 68 patients with congenital anomalies, four in patients with anomalies of form and position, and six in patients with hydronephrosis due to aberrant blood vessels.

Polycystic Kidney—Polycystic kidneys are not common and were present in only four cases of this series—three women and one man. Their ages varied from 38 to 51 years, the average being 43.75 years. All showed bilateral involvement.

The pyelograms usually show the pelvis and calices to be elongated, narrowed, and widely separated (Fig 13). Even though there may be marked deformity of the pyelogram, the contours are clear-cut with normal cupping of the minor calices. Rounded filling defects from marginal cysts are frequently present.

The fact that both kidneys are usually involved to the same extent and have pyelograms of similar appearance is also an aid in making the diagnosis of polycystic disease.

VISCELLANEOUS

Cellular Debris—One patient showed a filling defect in the opaque pyelogram,

confirmed by air pyelograms, which on pathologic examination was found to be a putty-like mass of cellular débris (Fig 14),

Cyst—A diagnosis of a simple cyst of the kidney was made in one patient, a woman 44 years old. These cysts usually

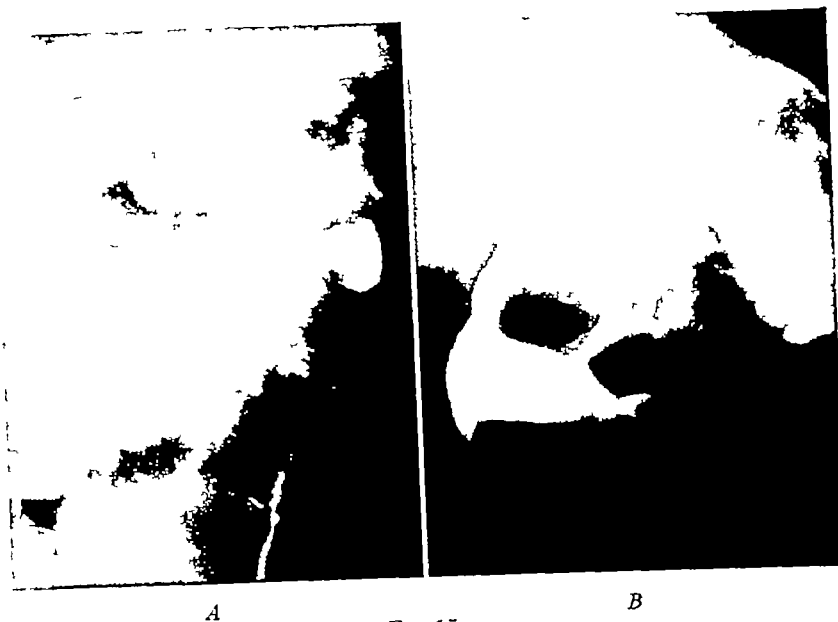


Fig 15

Fig 15-A Retroperitoneal metastasis from teratoma of testis. Kidney and ureter are markedly displaced and distorted.

Fig 15-B Perinephritic abscess following traumatic rupture of kidney.

the kidney pelvis showing metaplasia of the epithelium. This was diagnosed pre-operatively as a non-opaque calculus and even in retrospect shows no differentiating characteristics.

Retroperitoneal Tumors—The pyelograms in two of our cases showed marked deformity and displacement of the kidney due to retroperitoneal metastases from a teratoma of the testicle (Fig 15-A). These tumors frequently metastasize to the retroperitoneal lymph nodes, which may become so large as to occlude the ureter or displace the kidney and ureter. The pyelograms themselves are not characteristic.

Rupture of the Kidney—There was one case of ruptured kidney (Fig 15-B) occurring in a man 38 years old who fell from a height, striking on his left side. The pyelogram taken three weeks later showed extravasation of the opaque medium through the ruptured tissue into a perinephritic abscess.

attain a large size before being discovered and can then often be seen attached to the kidney. Because of the large size of the cyst the kidney is likely to be displaced, yet, as in our case, there may be no deformity of the kidney pelvis. At times, however, there may be flattening of the calices from pressure.

SUMMARY

A review has been made of the pyelographic findings in 432 consecutive patients having lesions of the urinary tract.

In this series infection was found most often, followed by hydronephrosis, renal calculus, congenital anomalies, ureteral calculus, neoplasms, and tuberculosis—in order of decreasing frequency.

Aside from these main groups a few scattered cases, such as retroperitoneal tumor, ruptured kidney, simple cyst, and cellular débris, were encountered. The various groups of kidney lesions have been

HEREDITARY DEFORMING CHONDRODYSPLASIA

By REUBEN G. ALLEY, M.D., *Pittsburgh, Pa.*

From the Diagnostic X-ray Department of The Western Pennsylvania Hospital

UNDER the general heading of dyschondroplasia a number of variants are described some are given separate names and described as clinical entities, yet the dividing line is not clean-cut and cases may be seen that show changes ascribed to more than one type. When the family here reported first came to our notice, the initial problem was accurate classification and therein we found a maze of synonyms and interrelated terms. As criteria for each were analyzed, it was found that every characteristic could be demonstrated in one or more cases, though in varying prominence. Some had a tendency toward exostosis, others revealed more enchondroma. Another had numerous tiny dense stippled areas that on first glance resembled osteopoikilosis, but films made with a different projection showed them to be in the soft tissue overlying the bones rather than in them. From a study

of this family we are prepared to agree with an opinion that many of these cases of disturbed bone growth are transitional phases between a single exostosis at one extremity and a fully developed hereditary, deforming chondrodysplasia at the other. After reading descriptions and discussions of related terms—Ollier's disease, hereditary multiple exostosis, diaphyseal aclasis, hereditary multiple enchondroma, multiple cartilaginous exostoses, and hereditary deforming chondrodysplasia—we decided upon the latter as more liberal and all-embracing, and so classified these cases.

The first patient seen by us was George, aged 12 years, who is No. 4 in our series. He was injured by an automobile and sent to the hospital with a fractured tibia. After seeing the bone conformation of his leg, the other long bones were also roentgenographed. During the examination he volunteered the information that several

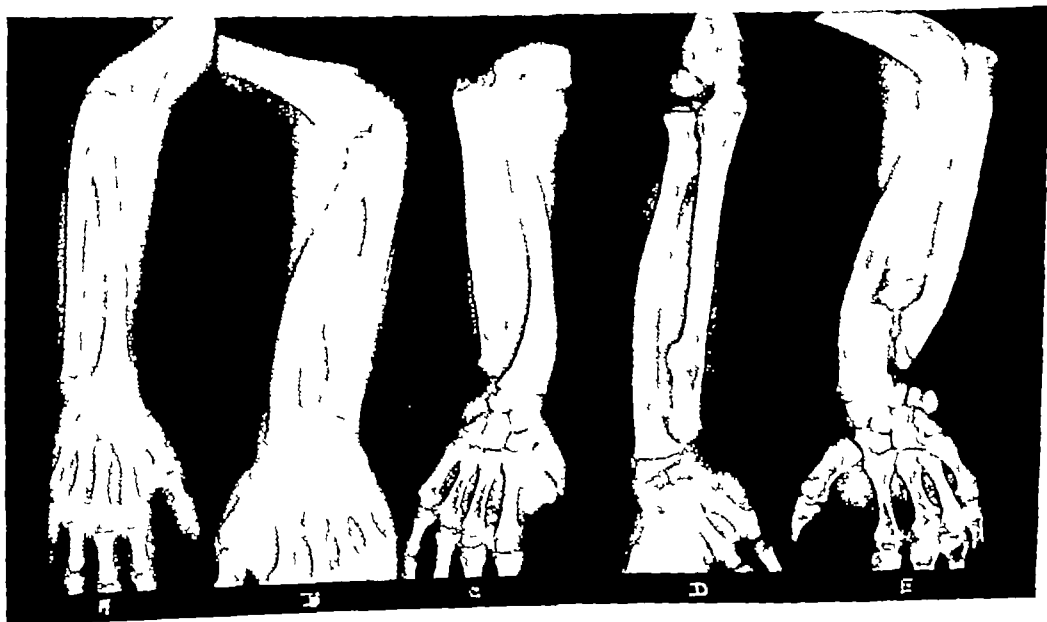


Fig. 1. Wrists and forearms of five children in the order of their ages. Ulnar shortening and bending are present in all but the youngest. Trumpeting of diaphyseal ends of long bones, decreased density with coarse striations, and exostoses of varying sizes are also noted.

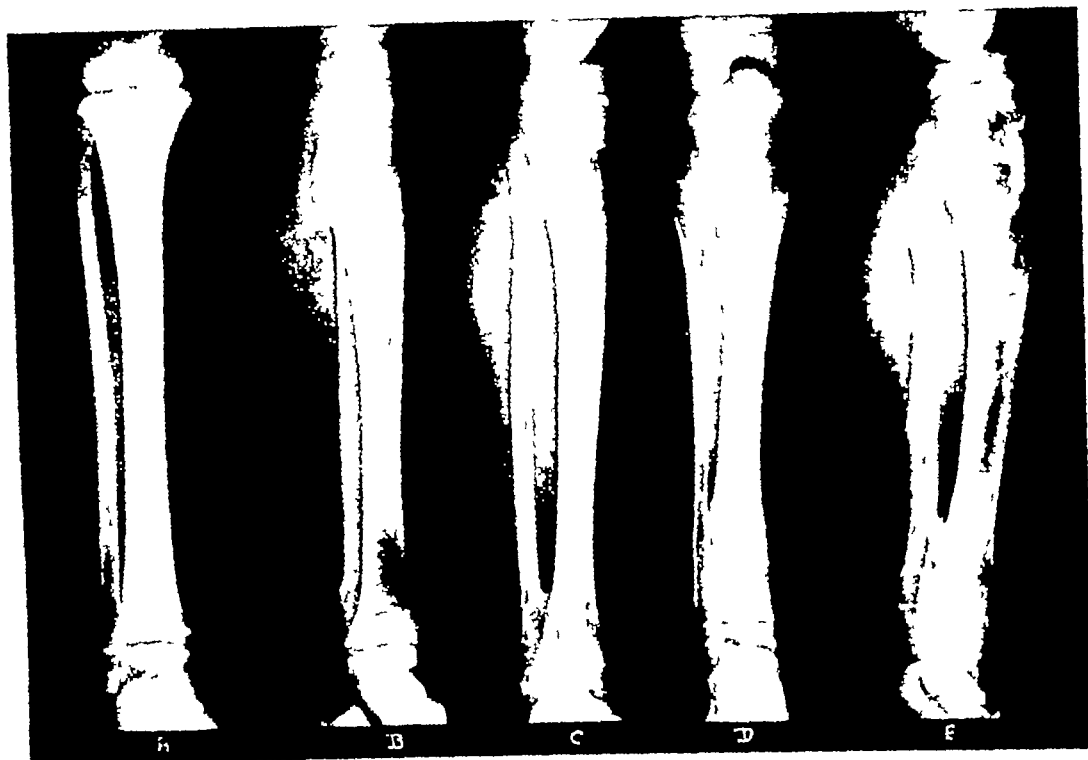


Fig 2 Lower leg films are also characteristic Exostoses slightly more marked, especially at proximal ends of fibulae

brothers and sisters also had "lumpy legs and arms" Due to the kindness of their family physician we were able to examine the parents and five children

The father and mother were free from bony abnormality Unfortunately, their family history cannot be considered accurate Each parent looked askance at the other and assured me, "Nobody like that in my family!" It was all too evident that it would never be admitted by either, regardless of fact An added difficulty was the circumstance that relatives of both live in Jugo-Slavia and no check can be made

The family history is not extensive as there were language difficulties as well as only limited co operation on the part of the parents Both were born in Austria, but not related There had been fourteen pregnancies with seven living children Two girls of 17 and 14 years respectively, are perfectly normal and may be described as "fat and rosy" The affected children

are sallow, underweight, and inclined to be short in stature This is more outstanding in the two older children, and superficial deformities are noted in three Only the x-ray films revealed pathology in the two younger ones

The mother tells us that the two normal girls were breast-fed until a year old, while all others, except the baby, were put on the bottle in a month or two and given no supplementary feedings of fruit juice or fish oil The youngest was breast-fed for a year and has been fed fruit juice Her films are included in this series because she is under the age when lesions first were noted in the other children, and because one foot shows changes we consider questionable (Fig 3-A) All of the children are described as being normal until after three, when "lumps" begin to appear Nick (B), who is eight, has very little superficial deformity, though the roentgen changes are typical No disability is complained of by the children

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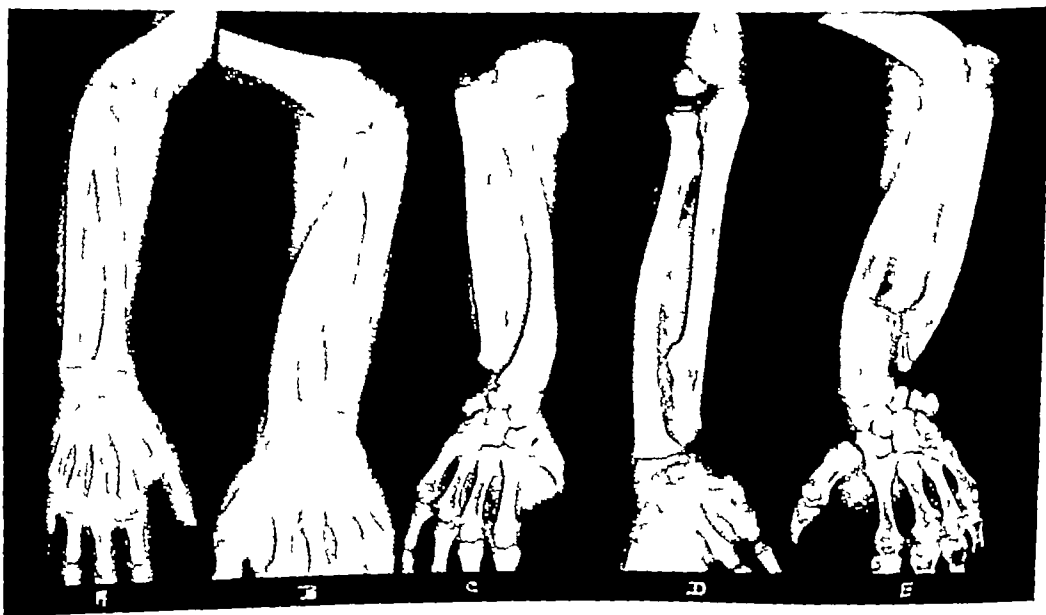


Fig. 1. Wrists and forearms of five children in the order of their ages. Ulnar shortening and bending are present in all but the youngest. Trumpeting of diaphyseal ends of long bones, decreased density with coarse striations, and exostoses of varying sizes are also noted.

The trabeculations are coarser and more dense and the chondromas are more prominent in the phalanges than in the long bones. Hereditary, deforming chondrodysplasia may be a similar disturbance. In its earliest state periosteum is really

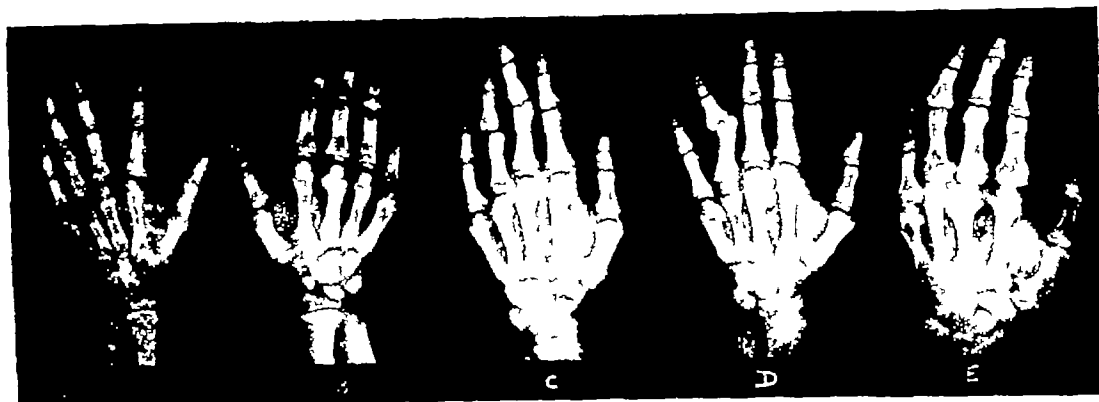


Fig 4 The hand film of the second child shows the minute dense areas in the carpal region. Chondromas are present in varying sizes in metacarpals and phalanges in our older patients

bones. No stippling is seen. The phalanges show chondromas at their proximal ends and the metacarpal involvement is more advanced distally. The hands are much more characteristic of the changes ascribed to Ollier's type of chondroma than those typical of multiple exostoses. However, the wrist and knee, as well as long bones, are quite characteristic of hereditary, deforming chondrodysplasia.

With these pictures before us the general subject is considered.

Hereditary, deforming chondrodysplasia is a disturbance of bone growth beginning early in childhood, and characterized by multiple cartilaginous and osteo-cartilaginous growths within or on the skeletal system. The microscopic appearance is in no way different from a single exostosis. It is a retardation of normal transformation of primordial cartilage into bone, and not primarily a bone tumor.

The following, briefed from Geschickter and Copeland's, "Tumors of Bone," seems to be the best explanation of the method of development.

A single exostosis is formed as an exaggeration of a normal bony protuberance when maladjustment occurs between the periosteum of the tuberosity and the pre-cartilaginous connective tissue of the ten-

perichondrium. If there is an arrest of development and tendency for precartilaginous tissue to persist, the bones of cartilaginous origin will be affected. The failure of periosteum to develop adequately results in two conditions: first, the cortex does not achieve its full thickness, and second, the periosteal envelope is inadequate and does not form an efficient limiting membrane to bone growth. This failure results in widening of the metaphysis and irregular protrusions through points of defect in the periosteum.

The clinical findings are few—visible lumps in the arms and legs, tumors of the fingers and toes, and pain or impaired function due to pressure. There are usually no neurological signs. Local paralysis or paraplegia may result from large tumors and at least one aneurysm from vessel trauma has been reported. Malignant degeneration usually takes the form of chondromyxosarcoma. The prognosis for life is excellent, but no cure is offered. Large masses may be surgically removed, but occasionally recur.

The roentgen appearance is striking and is the basis for positive diagnosis. Usually all long bones are involved, but the fibula and ulna show most characteristic changes. These bones are short, bowed, and—es-

They are attending school, each is in his or her proper grade, and none has been required to repeat a year's work

In him, enchondromal development is more marked than the exostoses. He is the only one who shows the small round



Fig 3 The phalanges and metatarsals are not greatly deformed but small enchondromas are present in all and surface deformity is quite marked in the two older boys

The only blood work done was on the original patient. His blood calcium was 10.3 mgm, phosphorus 5.1 mgm, and Kahn test negative. The following blood count was done on admission: red blood cells, 4,901,000, white blood cells, 24,150, hemoglobin, 80-90 per cent, polymorphonuclears, 86 per cent, large lymphocytes, 2 per cent, mononuclears, 2 per cent, small lymphocytes, 2 per cent, transitionals, 4 per cent, eosinophiles, 2 per cent, basophiles, 2 per cent.

As these cases show progressive development of the disease, we have arranged the films in chronological order for a better comparison of the lesions. Martha (A), who is 3 years of age, is first on all of the films and, reading from left to right, the others are Nick (B), aged 8, Mary (C), aged 10, George (D), aged 12, and Walter (E), aged 16.

Martha, as has been said, may belong in the class of normals—only time can decide that—but we feel that there is a small projection on the proximal phalanx of her right first toe (Fig 3-A) and slight irregularity of the metatarsal epiphysis. Otherwise she appears normal and there is no delay in the ossification of her epiphyses.

Nicholas has early lesions about equally developed on the right and left. The wrist and knee show characteristic changes

areas of increased density in the wrist (Fig 4-B). These are not in the already formed bones but can be shown as separate shadows when films are projected in other planes. Islands of dense calcification are reported in older cases of Ollier's disease, but this is the youngest definite case, and the calcification is not intra-osseal.

Mary has a greater tendency toward exostosis formation and her right side is more involved than the left, with the possible exception of the wrists. Chondromas are present in the wrist but there are very slight changes in the hand. Exostoses may be seen at ends of all long bones as well as in the mid-shaft of the humerus.

George, on the other hand, demonstrates an almost typical picture of that described for hereditary, deforming chondrodysplasia. There is widening of the metaphyseal ends of the long bones and longitudinal coarse striations, with areas of decreased density between them. The shortening and bowing of the ulna and fibula are very marked, with typical wrist and knee deformity. Simple chondromas are present in the phalanges, but are infrequent.

Walter has more marked shortening of the shaft, increased width in the ends of the long bones, and exostoses of all types

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pecially in the wrist and knee—bend toward the heavier bone and may even fuse with it. The diaphyseal ends of the bones are will predominate in one child and the other in another. The broadening of metaphyses is present in older cases and less



Fig 5 Films of the femora are not entirely satisfactory due to the effort to get both the proximal and distal ends on one film. However they show the exostoses as they develop with increased age.

vacuolated, broadened, and these contain stripes or striations which increase with age in both width and density. Exostoses grow from the cortical regions and follow the line of muscle pull. These growths may be of any type. Central enchondroma may be present and resemble a bone cyst. Phalanges, metatarsals, and metacarpals contain simple enchondroma, but carpal and tarsal bones are almost never affected.

In differential diagnosis certain requirements are stated:

- 1 Hereditary factor
- 2 Presence of ossifying enchondromas or exostoses
- 3 Broadening of metaphyses which begins abruptly and is called 'trumpeting'
- 4 Bone homogeneous, though enchondroma may be present

Our cases are not proven to show hereditary transmission, but the possibility cannot be ignored. Both exostoses and central chondroma are present, though one

prominent in the younger ones. As it seems reasonable to assume that all of these children have different stages of the same disease, and as some show a preponderance of exostoses and others an excess of the chondromal changes, we are forced to believe they are basically the same pathology. The criticism that the term "hereditary, deforming chondrodysplasia" confuses multiple exostoses and multiple chondromas becomes very pertinent, for the confusion appears to be not in the terms, but the nature of the lesion.

Summary—Four, and possibly five, cases of hereditary, deforming chondrodysplasia are presented. All are in the same family and they show progressive stages of development of this disease.

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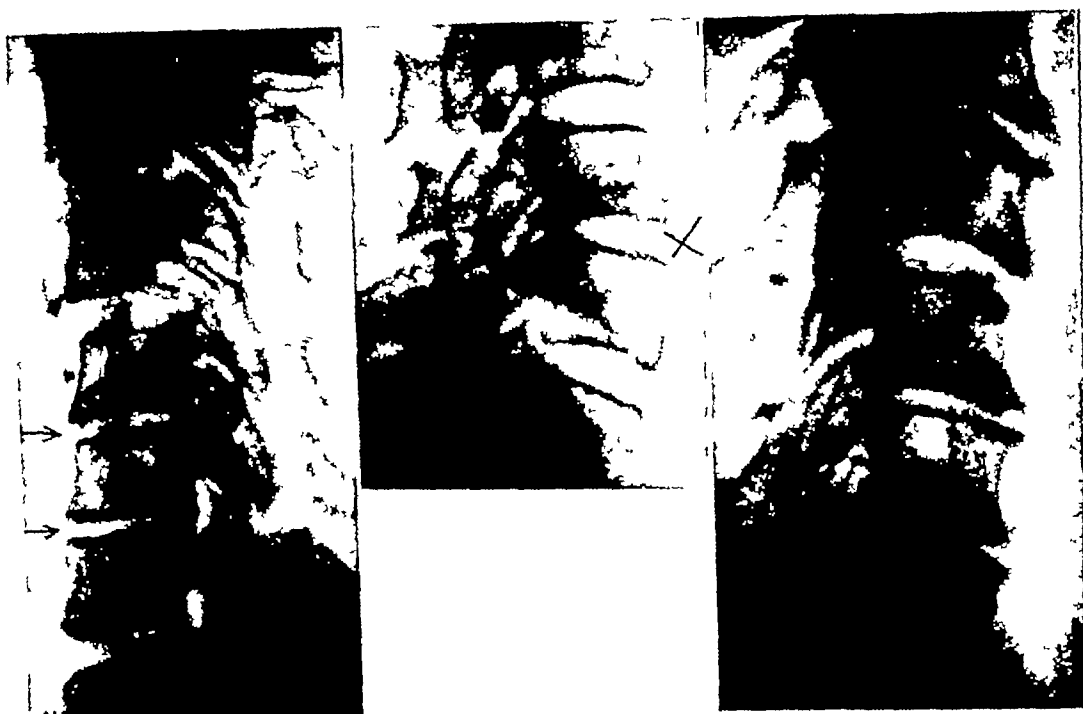


Fig 1-A

Fig 1-B

Fig 1 C

Figs 1 A, 1 B, and 1 C Discogenetic disease cervical spine (1-A) Marked thinning of two discs, no bony reaction (1-B) Thinning of the posterior part of one disc exostoses (arrows) at the adjacent posterior margins (1 C) Thinning of four discs, generalized exostotic deformities Note absence of any pathologic changes in the apophyseal joints

patient This method has proved highly satisfactory

The following report is based upon a study of more than a thousand roentgenologic examinations of the spine made in the course of three years

III TECHNIC

The examination in diseases affecting the foramina is based upon anterior, lateral, and oblique aspects Oblique views are taken from both sides, right and left To reproduce physiologic conditions, the views should be taken preferably, in the erect position the patient being instructed to refrain from any attempt to force himself into an unwonted posture, especially straightening of the spine In some instances, however, forced lordosis is advisable, as it shows early changes not yet visible in the ordinary position lordosis causes narrowing of the foramen (Brown) For the oblique view, the patient is posed with the back toward the film, the trans-

verse vertical plane of the body making an angle of from 45° to 60° with the film It is, of course, the foramen farther from the film that will be projected axially A focal distance of not less than four feet is preferable The penetration chosen should not be too high, otherwise early calcifications may escape visualization

IV PATHOLOGIC ANATOMY

It is evident that all destructive and all deforming processes may, under certain conditions, involve the intervertebral foramina Primary and metastatic tumors, Pott's disease, osteitis fibrosa, spondylolsthesis, and prespondylolsthesis are known to initiate such changes In this report, of the common chronic diseases of the spine that affect the foramina, only those are discussed which have not yet received systematic description

Narrowing of the foramen is produced either by breakdown of tissues that normally hold in place the bones encircling the

DISEASES AFFECTING THE INTERVERTEBRAL FORAMINA

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I CLINICAL RELATIONS

THE roentgen findings here presented concern a syndrome of recurrent or persistent pain, discomfort, and progressive disability clinically suggestive of rheumatism, arthritis, or referred symptoms from internal diseases. In observations recently reported by E. L. Turner and the present writer, segmental neuritis, resulting from compression of nerve roots within the intervertebral foramina, has been shown to be a common cause of these symptoms. In the case of backache and sciatica, the correlation with a special type of spinal lesion is well known, but it has not yet been generally recognized that similar diseases in other segments of the spine, as well as pathologic processes of a different origin, may and do produce narrowing of intervertebral foramina and symptoms of segmental neuritis in various regions of the body. As a differentiation of these conditions has been found useful in determining the appropriate treatment, an attempt is here made to classify the roentgen findings, especially those hitherto undescribed, that are typical of chronic diseases leading to compression of nerves within the intervertebral foramina.

II ROENTGENOLOGIC ASPECT OF NORMAL FORAMINA

Anatomically, the intervertebral foramen is bounded at its anterior margin by the posterior surface of the vertebral bodies (covered by the posterior longitudinal ligaments), the gap between the bones (intervertebral space) being filled by the posterior part of the annulus fibrosus of the intervertebral disc. The upper and lower margins are formed by the concave borders of the pedicles of the superjacent and subjacent vertebræ, respectively. The pos-

terior margin is marked by the synovial membrane and ligaments of the apophyseal joint. Roentgenologically, the structures involved are visible in lateral and oblique views of the spine. It is noteworthy in this connection that the direction of the intervertebral foramina (or, better, *passages*) is not the same in all parts of the column. Throughout the dorsolumbar region, the direction is almost exactly laterad, in the neck, it is oblique, midway between laterad and ventrad, forming an angle of about 45° with the median plane of the body, and again, the last (fifth) lumbar passage turns slightly ventrad. On the other hand, the apophyseal joints of the cervical vertebræ are lateral in position, and the narrow joint space between adjacent facets can be seen best in a strictly lateral view, while, in the dorsal region, the articular processes are placed farther back and the joint spaces are best seen in a slightly oblique view, from behind the transverse plane, the film making, with the median plane, an angle of less than 45° . Finally, in the lumbar region, the articular processes lie still farther back and, to make the joint spaces visible, the film must be inclined obliquely backward at an angle of very nearly 45° .

The size of the foramina is variable. After numerous trials made in the course of the last two years, the writer has abandoned the idea of exact measurement. The distance between the foramina and the film varies considerably with the transverse diameter of the vertebræ, the thickness of the intervening muscles, subcutaneous tissue, and skin, and the transverse diameter of the corresponding part of the body, thus producing variations in size according to the laws of projection. Wherefore, instead of relying upon figures that are, of necessity, falsely exact, one should compare by measurement the width of normal with that of abnormal foramina in the same



Fig 3-A

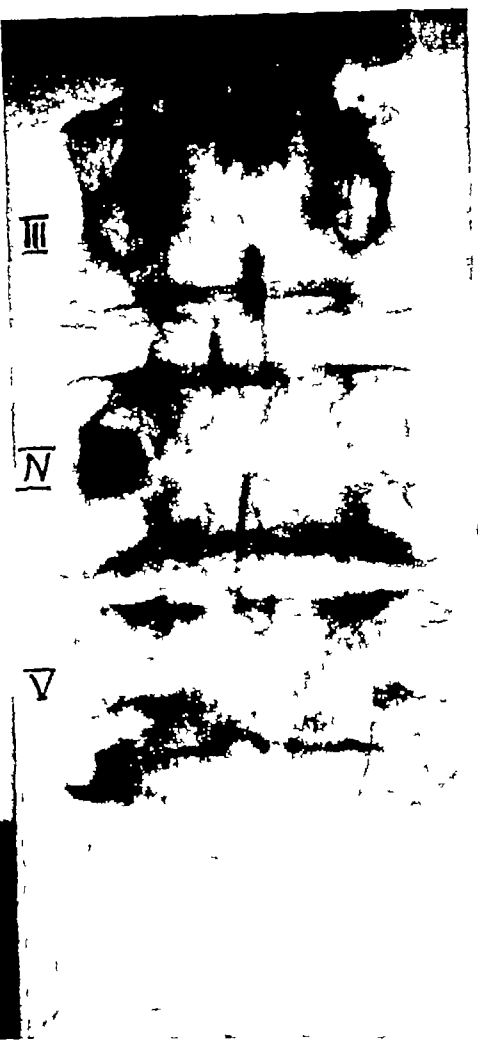


Fig 3-B

Figs 3 A and 3 B Discogenetic disease Typical localization in lower cervical and lower lumbar spine In this patient, the other sections of the spine were found normal Note exostoses in 3 A, corresponding to churning in 3-B

Hadley, Oppenheimer and Turner, and others) Pressure upon nerve roots results and may be aggravated by herniation of the disc into the spinal canal (Mixer and Ayer, Alajounine and Petit-Dutailis) The same mechanical changes (Fig 2) are produced by gradual thinning of the disc, which occurs either as a late consequence of trauma, many years after the injury, or as a result of degenerative processes (Schmorl) associated with dehydration (Pueschel), possibly also due to faulty posture (Brown) or hypothetical disturbances in nutrition (Oppenheimer and Turner)

Thinning of discs occurs most frequently in the lower part of the neck (fifth to seventh cervical vertebra), and in the lower lumbar region, especially at the lumbo-sacral articulation Now these are precisely the most flexible parts of the spinal column, and it is here, in these two regions, that (apart from the sacral nerves) the thickest nerve-roots issue from the spinal canal, namely, those concerned in forming the brachial and lumbar plexuses, respectively, from which the great muscular masses of the limbs receive their nerves But the intervertebral passages



Fig 2 A

Fig 2 B

Fig 2 C

Fig 2 D

Figs 2 A 2 B 2 C and 2 D Collapse of foramina in discogenic disease (2 A) Normal (2 B) Same case as shown in Figure 1 B, forward displacement of corresponding articular process (arrow) (2 C) Two articular processes displaced (2 D) Pronounced displacement, foramina 8-shaped. Note exostoses of the bodies in 2 D and tiny spurs at the tips of the processes involved in 2 C and 2 D in the absence of changes of the joint space

foramen, or by formation of tissues which encroach upon its lumen. It is convenient to distinguish these two different mechanisms by calling the former *collapse*, and the latter *constriction* of the foramen. Any part of the circumference may be affected

of disc material and to acute thinning often associated with herniation of parts of the disc into the spinal canal (Mixer and Ayer, Glorieux), or with extrusion of the nucleus pulposus, or a part of it, into the bodies of adjacent vertebrae (Schmorl's

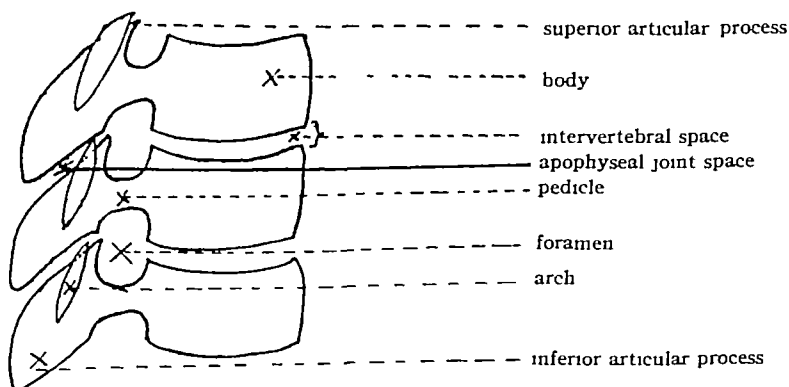


Fig 2 E

A COLLAPSE OF THE FORAMEN

(1) *Thinning of Intervertebral Discs (Discogenic Disease)*—Traumatic rupture of the annulus fibrosus, for example, after lumbar puncture (Milward and Groot), fractures or contusions of vertebrae, leads to leakage

nodules). The narrowing of the intervertebral space, thus produced, causes collapse of the anterior half of the intervertebral foramen followed by anterior subluxation of the superior articular process of the subjacent vertebra (Williams and Yglesias,



Fig 5-A



Fig 5-B

Figs 5-A and 5-B Progressive eburnation of the vertebral bodies in discogenetic disease Six months interval between 5-A and 5-B

of the foramen, in consequence of which the outline of the foramen comes to resemble the figure 8. The decrease in height is not always as clearly demonstrable. In quite a number of observations, the subluxation of the articular process was definitely more distinct than the narrowing of the intervertebral space. In serial examinations made at intervals of from six to eight months, progressive eburnation of the bony surfaces adjacent to narrowed intervertebral spaces is demonstrable (Fig 5), exostotic deformations follow eventually, on the vertebral bodies they appear as lipping of the anterior and lateral margins, on the articular processes, as dense rounded nodules or spurs projecting into the lumen of the foramen (Fig 2-D). Calcifications of ligaments do not occur in typical cases. If present, they are in general signs of an associated inflammatory process.

(2) *Rarefaction of the Articular Processes*. This is a comparatively rare condition recently described by the present writer. The etiology is unknown, in two

cases out of seven, pulmonary tuberculosis was present. The affected inferior articular process is decreased in height, irregular in bony structure, and slightly deformed. The tip of the articular process opposite to the diseased bone protrudes into the latter, thereby producing a lenticular impression surrounded by bone of increased density (Fig 6). There are no signs of thinning of discs nor of subluxation of apophyseal joints, showing that this condition is different from the bony impingement observed in discogenetic disease. The penetration of the superjacent into the softened process leads to collapse of the posterior part of the foramen. All the patients observed suffered from severe segmental neuritis. The commonest seat of this disease is the pedicle of the sixth cervical vertebra, which, even in normal spines, is often somewhat thinner than the adjacent ones. Moreover, it is probably subjected to greater compression than the others when the pedicles of the fifth, sixth, and seventh vertebrae are closely crowded together in backward movements of the neck.



Fig 4-A

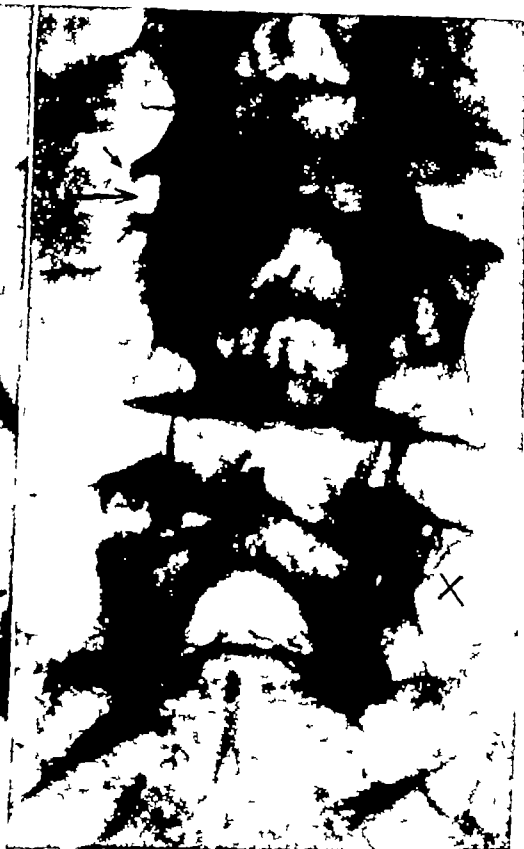


Fig 4-B

Figs 4-A and 4-B. Discogenetic disease. Sacro-lumbar disc destroyed, impingement of sacral process upon fifth lumbar vertebra (cross in 4-B). Compare position of upper (normal) with lower processes in 4-A. Unilateral (right) thinning of fourth lumbar disc, only the right articular processes are displaced (large arrow) exostoses only on the diseased side (small arrows). Apophyseal joints free in spite of displacement.

for the said roots are not wider (or, at least, not proportionately wider) than those in other parts of the spine where the nerve-roots are much more slender, consequently, the roots of the lower cervical and lower lumbar nerves are more liable to compression if their passages are reduced even slightly in caliber.

Not always is the whole of the disc found thinned, frequently it is only the posterior half (Williams and Yglesias), or one side, left or right (Oppenheimer and Turner), which appears reduced in height (Figs 2-B and 4-B). The mechanical irritation of the adjacent vertebral surfaces, due to abnormal contact resulting from defect of the disc, leads to the development of exostotic deformations (Keyes and Compere)

typical of hypertrophic spondylitis (Schmorl's deforming spondylosis). Similar alterations at the apophyseal joints may produce bony impingement upon articular processes (Hadley) or exostotic deformities at the tips of the processes involved (Oppenheimer).

Roentgenologically, the diagnosis is based upon the demonstration of a reduced inter-vertebral space and of subluxation of the articular processes. The reduction may be partial in the case of unilateral or posterior thinning of the disc, and less or more marked according to the degree of thinning. In the oblique view, the characteristic forward displacement of the lower articular process of the apophyseal joint is seen as a sort of step formed in the posterior border

costo-transversal articulations, hips, or joints Very recently, F Campbell Gold-shoulders (type Pierre-Marie-Struempell) ing has discussed various theories concern-

Fig 8-1

Fig 8-B

Fig 8 C



Fig 8-D

Fig 8-E

Figs 8-1 8-B 8 C 8-D and 8-E Spondylarthritis (8-A) Cervical spine, arthritic deformities with beginning ankylosis calcification of ligamentum flavum (8-B) Upper arrow indicates normal, lower arrow, ankylosed dorsal apophyseal joint (8-C) Ankylosis of dorsal apophyseal joints, with arthritic excrescences encroaching upon the foramina (8-D) Beginning ankylosis of one lumbar apophyseal joint roughening of articular surfaces (8 E) Ankylosis and exostotic formations of costo-transversal joints

If not arrested in its early stages, it results in ankylosis of the articular facets (spondylarthritis ankylopoetica), followed by ossification of the longitudinal ligaments of the spine (type Bechterew) Constriction of intervertebral foramina, in this disease, results from inflammatory swelling of the peri-articular tissues, or, later, from ossification of synovial membranes and ligaments, and arthritic deformities of the apophyseal

ing the etiology and pathogenesis of this disease

Roentgenologically, in early stages, the constriction, due to swelling of soft tissues, is not demonstrable In cases of segmental neuritis pointing toward a spinal lesion, however, mottled demineralization of the articular processes (Koch), or roughening of the articular surfaces of the apophyseal joints, are strongly suggestive of spondyl-



Fig 6 Rarefaction of sixth cervical articular process



Fig 7 Expansion of discs following softening of vertebral bodies Parathyroidism

(3) *Diseases of the Vertebral Bodies*—In these conditions, narrowing of the intervertebral foramina occurs only when the discs are affected by the underlying process. In infections and tumors of the vertebral bodies, this is not constant (Freedman). If the disc is involved, the same changes as those found in discogenetic disease will produce collapse of the foramen. A normal disc, on the contrary, owing to its expansion (measured by Petter) will widen the interspace between vertebræ softened by a rarefying process (Baron and Barsony, Moffat, and others), consequently, no narrowing of the foramina is observed (Fig 7). In this connection, one should remember that, owing to the particular condition of their nutrition, the discs are never found primarily infected, and that infectious ma-

terial must pass through the lamina cribrosa of the vertebral surfaces before reaching the annulus fibrosus. It is easy to see, therefore, that infections in the vertebræ do not of necessity involve the discs, accordingly, in infectious spondylitis compression of nerve-roots is not constant.

CONSTRICTION

B CONSTRUCTION OF THE FORAMEN

(1) *Primary Arthritis of the Apophyseal Joints (Spondylarthritis)*—This is an inflammatory disease involving primarily the synovial membranes of the apophyseal joints (Eugen Fraenkel), probably of bacterial origin (Nathan), and sometimes the result of focal infection (Golding, Oppenheimer). It may be systemic or localized, it may also be associated with rheumatoid arthritis in other joints, e.g.,

of peri-articular tissues, followed by ossifications of membranes and ligaments, will be found narrowed in the former condition, it is of normal width in the latter.

Fig 10 A

Fig 10-B

Fig 10 C

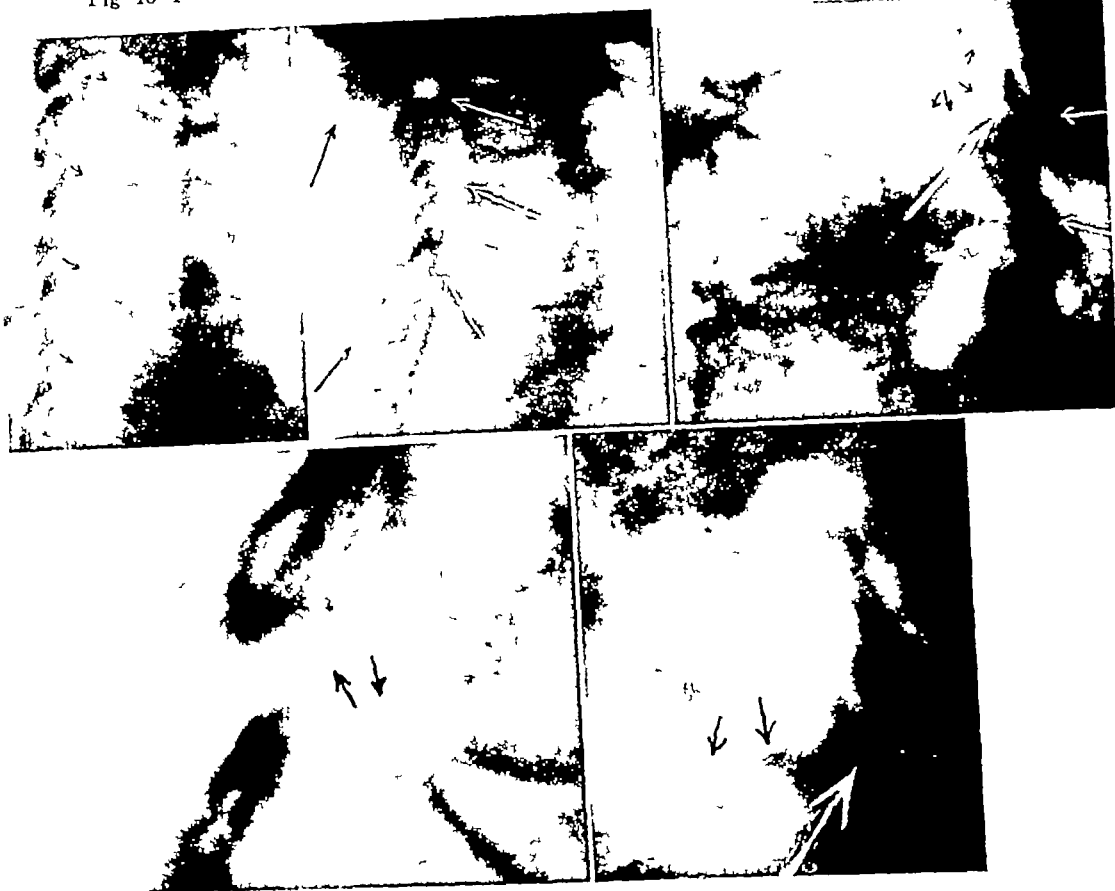


Fig 10 D

Fig 10 E

Figs 10 A 10 B 10 C 10 D 10 E Types of spondylarthritic constriction (10 A) Calcified posterior longitudinal ligament bulges into foramina (enlargement in 10 D) (10 B) Arthritic deformities (black arrows) and calcified ligaments (white arrows) (10 C) Arthritic deformities (black arrows) encroach upon the foramen beginning ankylosis of apophyseal joint (white arrows) Enlargement in 10 E

constrict the foramen by encroachment upon its lumen. In either case, deformities of the articular processes and abnormal ossifications of the vertebral bodies may complicate the roentgenologic aspect. Collapse consequent upon discogenetic lesions is often associated with those exostotic spiculations typical of hypertrophic spondylitis (Schmorl's deforming spondylitis). Constriction due to primary arthritis of the apophyseal joints is associated with calcifications of the longitudinal ligaments typical of ankylopoietic spondylarthrititis, but where is the intervertebral space

after Hypertrophic spondylitis (deforming spondylitis), however, is not caused by lesions of the disc only, as it is no more than a reaction consecutive to alterations of different origin. Ankylopoietic spondylarthrititis, on the other hand, is invariably correlated with ossifying changes in the apophyseal joints. Collapse results mainly from thinning of the discs hence it begins at the anterior margin of the foramen, constriction results from inflammation of the synovial membranes of the apophyseal joints, hence its commencement is at the posterior margin.

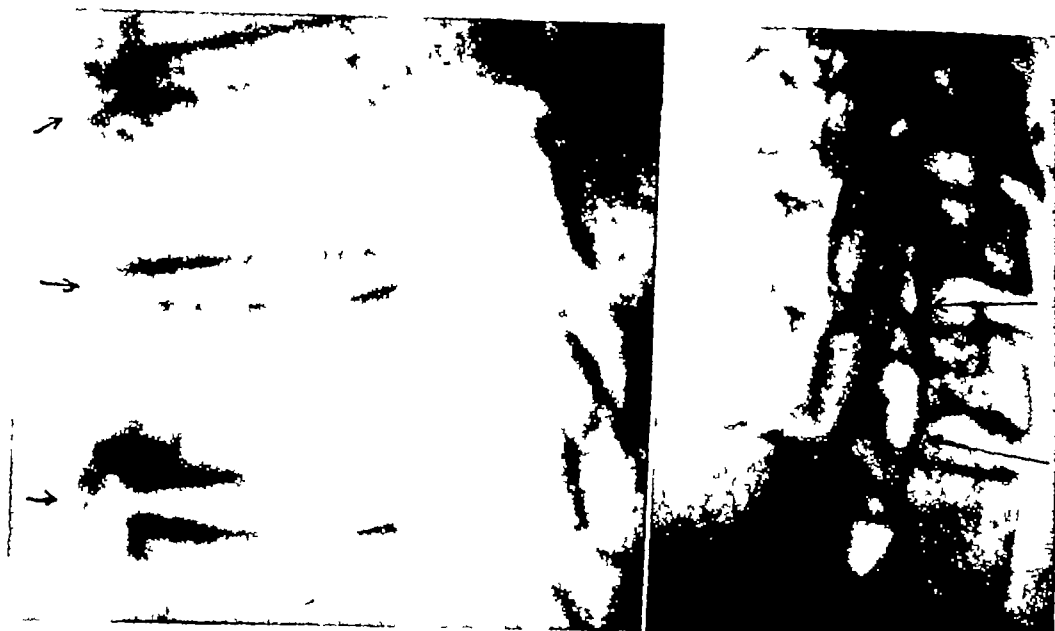


Fig 9 A

Fig 9 B

Figs 9 A and 9 B Spondylarthritis (9 A) Calcification of anterior (9 B) of posterior longitudinal ligaments Note ankylosis of lower apophyseal joints in 9 B Discs normal!

arthritis Generally speaking, the oblique view will show thornlike prominences at the tips of the articular processes (Fig S-C) In more advanced stages, ossifications of apophyseal ligaments are made visible by the lateral view Sometimes, concentric layers of calcified tissues narrow the lumen of the foramen (Figs 10-B and 10-E) Finally, ankylosis of the facets is demonstrable in the lateral aspect, and is almost invariably associated with calcifications of the longitudinal ligaments connecting the vertebral bodies The anterior outline of the foramen is marked, in these cases, by a dense linear calcification bridging over the posterior part of the intervertebral space (Fig 10) It is essential to note that the intervertebral space remains normal in width, as the discs are not affected by the disease This makes it possible to distinguish between primary arthritis and the secondary changes mentioned as occurring in discogenetic disease

(2) *Spondylosis ossificans*—Calcification of apophyseal ligaments may also occur in non-inflammatory diseases, degenerative processes being known to initiate ossifica-

tions (Schmorl) Bakke has recently described a condition which he has named *spondylosis ossificans ligamentosa localisata*, and which is marked by ossification of the ligamenta flava He considers that abnormal tension of these ligaments initiates the changes The distinction between this disease and a localized type of spondylarthritis ankylopoetica seems, as yet, difficult to establish Roentgenologically, linear calcifications between the tip of the articular process and the pedicle may, in the absence of other spondylarthritic changes, suggest Bakke's *spondylosis ossificans*

V CONCLUSIONS

Two groups of diseases, differing distinctly in origin and mechanism, may lead to narrowing of intervertebral foramina Following the breakdown of tissues which normally support the bones encircling the foramen, mechanical collapse occurs and results in decrease in height, with consequent luxation of the articular process, causing decrease in the lateral diameter On the other hand, inflammatory swelling

APPARATUS FOR THE SO-CALLED MUCOSAL RELIEF TYPE OF GASTRO-INTESTINAL EXAMINATION

By JOSEPH C BELL, M D , *Louisville, Ky*

MY interest in the above type of examination dates from the appearance of Akerlund's excellent article on this subject in the January, 1931, issue of the "American Journal of Surgery". Since that time seven different film-carrying devices with provision for localized pressure over the part being examined have been designed, constructed, and given a thorough trial in my work. The first four were crude and proved entirely unsatisfactory. The fifth was more satisfactory (described in RADIOLOGY, February, 1935, 24, 143-152). At this same time, apparatus was described by which one could change from the fluoroscopic set-

change-over switch has been in constant use for the past two years and is satisfactory in all respects.

Excellent films were secured, but the apparatus was difficult to operate, and no provision was made for maintaining pressure except by hand power. This tunnel was followed by the sixth which was much more nearly that for which we were seeking. A suitable device for maintaining pressure was incorporated, using the lock of the pressure band of a Bucky diaphragm. This lock is most satisfactory for it maintains any desired pressure with almost no rebound, and can readily be released.

The first three devices provided for

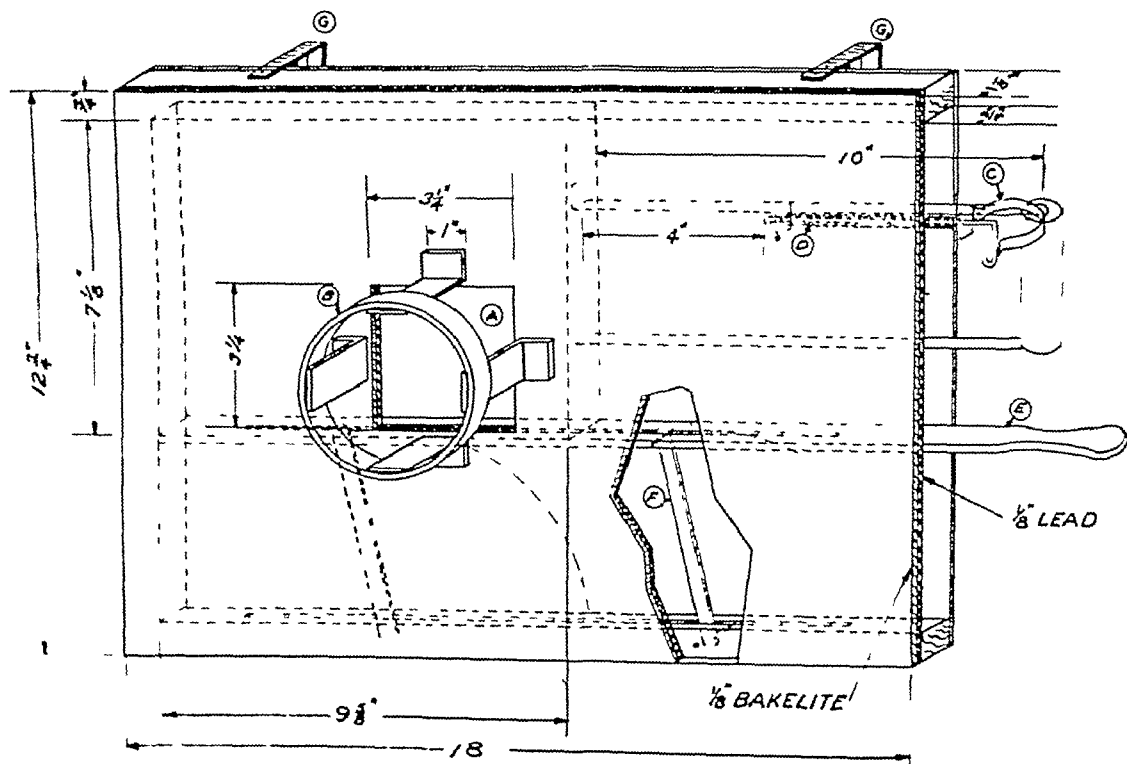


Fig 1 Drawing of tunnel now in use.

ting to the radiographic, and then make the exposure by means of a hand-controlled magnetic switch. This so called quick

a single exposure on a 5 X 7-in film. In the fourth and fifth, four circular exposures, each 3 1/2 in in diameter, were made

The clinical consequences and therapeutic measures determined by these mechanisms have been discussed in a separate report

VI SUMMARY

1 In the classification of diseases that involve the intervertebral foramina, *collapse* of the foramen is distinguishable from *constriction*. The roentgenologic appearances are described

2 *Collapse* is produced by softening, rarefaction, or loss of elasticity in tissues which normally support the bones that encircle the foramen. Thinning of intervertebral discs (discogenetic disease) and rarefaction of articular processes invariably cause collapse

3 *Constriction* is produced by inflammatory swelling of the synovial membranes of the apophyseal joint, followed by calcification of ligaments and ankylosis of the facets. The discs are not involved

4 The correlation of these conditions with hypertrophic spondylitis (deforming spondylosis) and ankylopoietic spondylarthritis is discussed

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Fig. 5 Serial exposures of duodenal cap under varying degrees of pressure showing field of exposure.

Fig. 6 Serial exposures of another duodenal cap. Ulcer crater near apex. Patient had been under treatment. Ulcer crater was more sharply defined before treatment was instituted.



Fig 2

Fig 3

Fig 2 Photograph of tunnel attached to the fluoroscopic screen. Exposure switch is shown in position. Tube above screen not used in this work.

Fig 3 Photograph from operator's side of fluoroscope. Exposure switch shown on left. Lock for maintaining pressure shown on extreme right. Lock has fixed release when not in use.

on an 8×10 in film. The film was turned by hand after the first two exposures in order that the third and fourth could be made. It then occurred to me that four exposures, each $3\frac{1}{4}$ in in diameter, could be made on a $6\frac{1}{2} \times 8\frac{1}{2}$ in film, and with a suitable shifting device, that these could be made without rotating the film and without any increase in the weight and size of the apparatus over that used with the 8×10 -in film tunnel. In this tunnel the position of the film was governed by a track

in which a film carriage bearing ran. It worked well but was difficult to construct, and the track interfered with fluoroscopy by cutting down the size of the opening through which one observed the part being examined. To remedy the above defects the seventh tunnel was constructed. It has now been in use for several weeks and satisfies all the requirements for this type of work, as I see them. The construction is relatively simple and relatively inexpensive. The size is just that of the ordinary fluoroscopic screen holder and the weight only 12 pounds and 8 ounces.

The following principles have constantly been kept in mind in dealing with this problem.

First, that the apparatus should be readily adaptable to that already in use in any well-equipped office or hospital at reasonable expense. This is true both of the so-called quick change-over switch and of the tunnel with its locking device.

Second, that it be simple both in construction and operation. This requirement is also satisfied. When the quick change-over switch operating mechanism is made a part of the film-shifting device the construction becomes complicated. Aside from this objection, it is not desirable to have this arrangement because the



Fig 4 Normal cap under varying degrees of pressure

and should be used in the usual manner many times more often than it will be for this work. For this reason it is logical to encourage inadequate fluoroscopy. It must be remembered that this method of examination will not be applicable or necessary



Fig. 8. Films of same case as shown in Figure 7 made with patient upright, using above described compression apparatus. Degree of compression and angles were varied between exposures. Upper four views show distortion of mucosal folds of cap with only a suggestion of a niche. Niche is well shown in three of the lower exposures.

attach the apparatus to the fluoroscopic screen when it is needed rather than to have a fixed or semi-fixed apparatus which may in quite a large percentage of cases. It will not take the place of careful fluoroscopy, nor will the so-called spot film re-

switch will be used constantly for purposes other than for making the so-called spot film. I use it at all times when I wish to

that are present one instant and gone the next. In my experience, if organic changes are present they are relatively easy to



Fig 7 Serial films of distal third of stomach and duodenal cap made with patient prone using the ordinary serial tunnel. Slight deformity of cap is present. Distortion of mucosal folds faintly shown.

record anything just as it is seen with the fluoroscope. This includes some lesions of the chest, some of the heart or great vessels, and many lesions of the esophagus, the gall bladder, the colon, and of the spinal cord. In addition to these, all serial or single exposure films of the stomach and duodenum are made with this switch.

It is well to bear in mind the fact that we are not trying to demonstrate changes

demonstrate by this method in most cases and do not require an instantaneous exposure. When a defect is so transient as to demand such an exposure, it probably has no organic basis, and a diagnosis based on such evidence may frequently be erroneous.

The third principle is that the apparatus should not interfere with the usual fluoroscopic examination. The fluoroscope will

and should be used in the usual manner many times more often than it will be for this work. For this reason it is logical to encourage inadequate fluoroscopy. It must be remembered that this method of examination will not be applicable or necessary



Fig 8 Films of same case as shown in Figure 7, made with patient upright, using above described compression apparatus. Degree of compression and angles were varied between exposures. Upper four views show distortion of mucosal folds of cap with only a suggestion of a niche. Niche is well shown in three of the lower exposures.

attach the apparatus to the fluoroscopic screen when it is needed rather than to have a fixed or semi-fixed apparatus which may

in quite a large percentage of cases. It will not take the place of careful fluoroscopy, nor will the so-called spot film re-



Fig 9 Serial exposures of normal gall bladder

place films of the usual type I am greatly interested in this examination and use it in an increasingly large percentage of cases as my experience with it grows, nevertheless, my fluoroscopic examination is no less careful, but more so if anything, and each year I become more firmly convinced of the value of serial films (as described in the previously mentioned issue of RADIOLOGY) These three methods go hand in hand and will continue to do so in my work

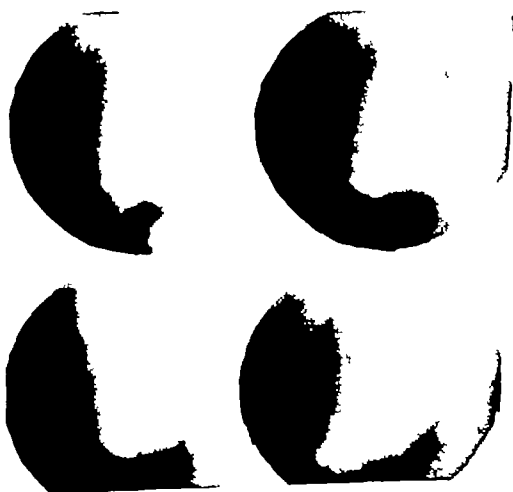


Fig 11 Same case as shown in Figure 10 showing stones in fundus with patient upright Serial tunnel in use



Fig 10 The ordinary type of gall bladder film showing somewhat atypical stones

DESCRIPTION OF FILM TUNNEL

Figure 1 is a drawing showing the construction of the tunnel now in use. It is designed for use with a $6\frac{1}{2} \times 8\frac{1}{2}$ in film, the long diameter being horizontal.

A, the exposure portal, is $3\frac{1}{4}$ inches square. In the earlier models we used a round portal $3\frac{1}{4}$ inches in diameter, but since the shutters on most fluoroscopes form a square or rectangle and not a circle, it seemed logical to use a square portal because the fluoroscopic portal determines the amount of secondary radiation and not the opening in the tunnel. In addition to this, we desired as large a portal as was



Fig 12 Serial exposures of rather faint gall-bladder shadow with large stone in fundus



Fig 13 Film of colon after opaque enema showing filling defect in proximal part of sigmoid. The defect is evidently due to a pedunculated tumor, probably a polyp, which may well be undergoing malignant change

consistent with good detail. Compression, however, is best made with a hemisphere because of the relationship of the parts being examined to the bony structures, and for this reason the ring *B* supports a removable hemisphere of aluminum. The hand switch for control of the quick change-over switch slips into the clamp *C* when the tunnel is in use, and exposures are made by pressure with the thumb. The hand grips the handle below the clamp *C* and shifts the film between exposures.

The device *D* was a rather complicated one for the purpose of stopping the film carriage when it had been moved into the proper position for the first and third exposures. It has been replaced by a small fixed metal shoulder welded to the side of the arm connecting the handle with the pan that holds the cassette. The arm is not as wide as the opening in the tunnel, and as the pan is pushed inward the arm is



Fig 14 Serial exposures of sigmoid of same case shown in Figure 13. The patient was supine and the films made with localized pressure over the lesion in the sigmoid. They illustrate the use of the above apparatus in the horizontal position.

pulled slightly toward the operator until the shoulder strikes the edge of the tunnel. The exposure is then made. The arm is pushed away from the operator, and the film can then be moved inward into position for the next exposure.

E is a metal support which, when in the position shown, holds the film in position for the lower two exposures. The metal rods *F* hold it in this position and we have added a small spring lock at the margin of the tunnel to prevent the support from falling accidentally. After the first two exposures are made the lock is released, the support is pulled outward and drops to the bottom of the tunnel, where the film rests ready for the third and fourth exposures.

"*G 1*" and "*G 2*" are rubber-covered metal hooks with which the tunnel is suspended from the fluoroscopic screen holder. If one wishes to use the tunnel in the horizontal position, this may be done by clamping the lower margin to the margin of the screen holder.

OPERATION

The patient swallows a small amount of barium suspended in water. This is spread over the walls of the stomach or duodenum and careful fluoroscopic observations are made. If evidence of an organic lesion is

found, or a suspicious shadow observed, the tube is centered over this area and is locked in this position. The tunnel is then attached, the proper degree of pressure is obtained, and the exposures are made. No counter balance for the tunnel is employed with the one that is now in use because it is so light that this is not necessary.

ILLUSTRATIONS

The illustrations are chosen for the purpose of showing the area of exposure rather than striking pathology. The gall-bladder films are included because the value of films made in this way has recently been emphasized by Ettinger in the "American Journal of Roentgenology and Radium Therapy" (May, 1936, 35, 656-661). Accurate centering is necessary if satisfactory

films are to be made, but this is usually possible.

COMMENT

Some of the ideas used in the construction of this apparatus are original with the writer, but many are adaptations of methods used by others who employ this type of examination. If this work has any merit much of the credit is due Mr J W Fowler, of the technical staff of the Norton Memorial Infirmary, who constructed the recent tunnels. The general ideas have been mine, but many of these ideas have been modified, improved and made practical from a construction standpoint, by him.

402 Heyburn Bldg

FRACTURE-DISLOCATIONS IN THE REGION OF THE ATLAS AND AXIS, WITH CONSIDERATION OF DELAYED NEUROLOGICAL MANIFESTATIONS AND SOME ROENTGENOGRAPHIC FEATURES¹

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DISLOCATIONS and fractures of the first two cervical vertebræ have been accorded considerable attention in the literature. Almost all possible types of disturbance of the structures of this region have been reported. The typical cases of "broken neck," with characteristic local signs and symptoms, and a neurological picture of cord compression, are easily recognized although, unfortunately, these often fall into the fatal group. In the less severely traumatized cases, in which the local signs and symptoms and the nervous manifestations occur with or shortly after the accident, the condition is suspected clinically, and usually the diagnosis is confirmed by the roentgen examination.

There is, we believe, a type of fracture-dislocation in the upper cervical vertebræ which has not been emphasized in the literature. These cases present obscure, slowly progressive neurological signs and symptoms years after the trauma. At the time of the injury local signs and symptoms are absent, insignificant, or they rapidly disappear and leave no residual local disturbances. These cases become neurological diagnostic problems.

The importance of delayed signs and symptoms in fractures and dislocations of the atlanto-axial region has been mentioned by various writers. Osgood and Lund (1), in a discussion of 55 collected cases of fracture of the odontoid process, mentioned five cases in which the neurological picture did not develop until some time after the initial injury. Ogilvy (2) also called attention

to the delay in the development of the signs, although his case had a latent period of only four days. Jackson (3), while reporting no illustrative cases, stated that "neurological symptoms may not appear until after the lapse of years, due to the slow development of myelitis." Bernstein (4) reported a case of anterior luxation of the atlas on the axis in which the neurological signs did not appear until 71 days after the accident. He referred to two other reports of delayed neurological signs: one of von Pries in 1792 with an interval of 60 days, and another of Costes in 1852 with an interval of four months. Ely (5) reported a case of dislocation of the atlas on the axis with fracture of the odontoid process in which signs of cord compression developed nine weeks after the injury. After failure of conservative therapy, he resorted to tying together the posterior arches of the atlas and the axis following which the patient made a complete recovery. Elliott and Sachs (6) described a patient with fracture of the odontoid process and atlanto-axial dislocation who developed recurrent paralysis following subsequent trauma with redislocation.

Other cases have been described in which neurological signs develop after a latent interval of from two to eight months.

In the above cases local signs were present and a history of injury was obtained. The interval before the onset of the neurological signs varied from four days to eight months. The neurological signs and symptoms were more or less rapidly progressive in all cases.

REPORT OF CASES

Case 1 W. R., a white male, aged 34,

¹ The authors wish to express their thanks to Dr. Eugene Pendergrass of the Department of Radiology, the late Dr. C. H. Frazier of the Department of Neurosurgery, and Dr. William G. Spiller of the Department of Neurology for their helpful assistance and for the use of their records.

complaining of "dragging of the right leg," was admitted to the service of Dr William G Spiller at the University Hospital on Nov 9, 1934

The limping was first noted by a neighbor in 1928. Since 1930 there had been a slowly progressive increase in the limp, so that at the time of his admission he felt that he had to drag his right leg as though it were made of wood. He had no pain or sensory disturbance. The systemic review was negative. The past medical history, family history, and social history were essentially negative.

Physical Examination—The general physical examination was entirely negative. The movements of the neck were free and equal.

Neurological Examination—(Dr M J Cooper, Nov 13, 1934) "The right lower limb is spastic, and the toe of the right foot drags as he walks, more because of spasticity than because of any foot drop. The flexion of the right knee with each stride is quite limited. There is some spasticity of the left lower limb also, but it is less than on the right side. Both arms swing moderately well in walking, but the swing of the right arm is more limited than that of the left. The patient is naturally right-handed. The motor power of the right upper limb is slightly reduced at the shoulder girdle, a little more reduced in movements at the elbow joint, and moderately impaired in the hand grasp and in the use of the intrinsic hand muscles. The left upper limb has approximately normal power except for a little weakness of the hand grasp. Movements at the hip and knee of the right lower limb are moderately weak, while in the left lower limb these movements are only slightly less powerful than normal.

"The peroneal muscles of the right side are a little weak, those of the left side are only slightly weak. The tibials are moderately weak on the right and about normal on the left. The calf muscles are considerably weakened on the right and only slightly weakened on the left. The coordination of all four limbs is about normal

except for the slight impairment due to spasticity. The tendon reflexes of the upper extremities are considerably exaggerated on both sides. The Trömner reflex is markedly positive on the right and moderately positive on the left. The epigastric, lower abdominal, and cremasteric reflexes are absent on both sides. The patellar and Achilles reflexes are greatly exaggerated on both sides. Patellar and ankle clonus were present on both sides. There is an intense defense withdrawal of the right and left lower limb on plantar stroking, more intense on the right side."

Examination of the cranial nerves was negative. The sensations of touch, passive motion, position, and vibration were normal. Sensations of pain and temperature were slightly less acutely perceived on the left side of the trunk, although no definite line of demarcation was obtained.

Laboratory Findings—Urinalysis and blood count revealed normal findings. The Wassermann and Kahn blood tests were negative. The first examination of the cerebro-spinal fluid revealed a medium positive Kahn test, a colloidal gold curve of 000111000, 4 leukocytes per c mm, and 41 mgm per cent of protein. On two subsequent examinations the cerebro-spinal fluid was found to have a negative serology, a colloidal gold curve of 0000000-000, protein content of 21.9 mgm per cent, and 5 cells. The Queckenstedt test caused a rather limited rise of the cerebro-spinal fluid pressure after bilateral jugular compression (80 to 100 mm of water rise above initial pressure). The rise and fall were prompt. A partial block was suggested but the evidence was considered to be inconclusive.

The roentgen examination of the lumbar spine was negative. The first roentgen report concerning the cervical region stated that there was an anterior dislocation of the atlas with the comment that a fracture of the odontoid process incident to the dislocation cannot be excluded. A later report following more careful studies of the region revealed a fracture-dislocation of the atlas on the axis. The odontoid proc-

ess was fractured and carried forward with the head. The atlas maintained its normal relation to the base of the skull (Fig 1).

At first no history of an accident was secured. After the roentgen examination, upon direct inquiry, the patient did remember having fallen about fifteen feet from a hayloft at the age of ten years. He believed that he had struck his head and neck. He was unconscious for a short time and was semi-stuporous the rest of the day. The following morning it was noted that his head was tilted to the right and he was unable to straighten it because of pain in the back of the neck. A physician was consulted and suggested no special treatment. The patient remained unimproved. Several days later he was taken to an old woman of the neighborhood who placed him in a chair and with sudden force lifted his head erect. There occurred a sharp pain and a grating noise was heard. Recovery was complete and to this day there has been no difficulty in the movements of his head and neck.

Course—The patient decided against the suggested operation for reduction of the dislocation and returned to his home unimproved. On April 3, 1936, the patient returned to the hospital for re-examination. He had remained much the same except that during the past year he had experienced some increasing pain in his right hip. A physical and neurological examination revealed that there had been no progression in his signs since discharge in December, 1934. No sensory disturbances were noted on careful examination. Roentgenograms of the atlas and axis were taken and an "old fracture of the odontoid process with dislocation of the atlas on the axis" was reported. The blood count, urinalysis, and blood serology were negative. He again refused operation and was discharged on April 4, 1936.

Case 2 R. W., a white female, aged 53, with the chief complaint of weakness of the right leg, was admitted Nov. 7, 1928, to the service of Dr. William G. Spiller in the University Hospital.

About one year prior to admission the patient first noted a lack of confidence in the use of her right lower extremity after considerable exercise. During the next six



Fig 1 Case 1 Showing the fracture-dislocation and marked displacement of the atlas on the axis

months this difficulty slowly progressed. She found it difficult to keep a soft cloth slipper on this foot. In walking along a dusty road, she noted that the top of her right shoe became covered with dust, and the right leg seemed to be thrown forward in walking. There was some difficulty in getting into bed because of the weakness of the right leg, and when in bed she was not able to turn as well as before. A gradual loss of strength and slight emotional instability had been noted.

About three months before admission there appeared some difficulty in the use of the right hand in writing. The writing movements became jerky, the writing was almost illegible, and the patient was rather reluctant to use her right hand. She complained of an inability to hold objects readily in this hand, and occasionally she had spilled liquids from tumblers and cups. For some time she had complained of numbness in the tips of the fingers of both of her hands.

About five years before the onset of these neurological disturbances, the patient was thrown from her horse, striking the back of her head upon a rock. She was taken

home unconscious but soon thereafter walked upstairs to her room and called her husband on the telephone. When he arrived he found her unconscious. She had no recollection later of having called him. After about three-quarters of an hour of semi-stupor she regained consciousness. She had a slight headache for a few days but never complained at any time of any pain in the neck or back of the head. Her husband dated the onset of her emotional upset to this event. She led her usual active life until the onset of the symptoms described above, five years after the accident.

Past medical history, family history, and social history were unimportant.

Physical Examination—Revealed an abnormal prominence of the upper thoracic vertebrae causing a slight protrusion in this area. There was no stiffness in the movements of the neck. The examination was otherwise negative.

Neurological Examination—(Dr William G Spiller) The mental status and cerebellar and sensory examination were entirely normal. The cranial nerves presented no abnormalities. The muscle power in the right lower extremity was diminished as compared to the left. Weakness of the right upper limb could not be detected objectively.

Reflexes	Right	Left
Biceps and triceps—	somewhat exaggerated on both sides	
Patellar and Achilles—	slightly more prompt	normal
Ankle clonus—	absent on both sides	
Babinski—	present	absent

Course—Examination of the optic fundi revealed no pathological changes. The visual fields were entirely normal. On Nov 7, 1928, Dr Temple Fay attempted an encephalogram. As the operation proceeded it became evident that a blockage of the subarachnoid space must exist, for only 67 c c of fluid were obtained. In addition, each introduction of air caused severe pain at the base of the skull and in the neck. The usual roentgenograms of the head were taken, as well as some films

of the upper cervical region in an effort to demonstrate an air level.

The cerebro-spinal fluid was clear and colorless and was under an initial pressure of 10 mm of mercury. There were 5 lymphocytes per cubic millimeter and 200 erythrocytes. The total protein content was 44 mgm per cent. There was a slight decrease in the sugar content. The Wassermann reaction was negative and the colloidal gold test was read as 0000131100.

The initial examination of the roentgenograms taken following the unsuccessful encephalogram reported head negative, pituitary fossa within normal limits of size (anteroposterior 8 mm, depth 10 mm), no air could be demonstrated in the cisterna magna, the upper five cervical vertebrae were negative. Because of the evidence of a block in the subarachnoid space, further roentgenograms of the upper cervical vertebrae were taken, and the previous films were studied more carefully. The following report was returned: fracture dislocation of the atlas on the occiput, the odontoid process was fractured but the fragments were in good position, slight posterior and lateral dislocation of the head on the cervical spine.

The patient was transferred to the Neurosurgical service of Dr Charles H Frazier in the University Hospital. On Nov 15, 1928, a laminectomy was performed with the removal of the laminae of C1 and C2. From Dr Frazier's operative notes we secure this interesting observation: there was no evidence whatever of any constriction or anything to impede the passage of fluid or air into the cranial cavity, the dura and the arachnoid seemed thickened and the arachnoid somewhat opaque. The spinal cord appeared to be normal. The post-operative course was uneventful except for a mild pyelitis. On discharge from the hospital on Dec 6, 1928, a neurological examination revealed no evidence of improvement.

On several occasions throughout the following years the patient has communicated her status to the physicians in charge of her case. At first there was some im-

provement The patient was able to walk without the use of a cane Her handwriting improved Only when she was greatly fatigued did the right lower extremity afford her any difficulty The last report (1934) indicated that the neurological manifestations had remained fairly stationary since the slight post-operative improvement and had shown no tendency to become worse The slight difficulty in the use of the right upper and lower extremities persisted, especially when she was fatigued The Babinski sign was still present on the right The patient led an active life and was not greatly inconvenienced by these infirmities

NEUROLOGICAL CONSIDERATIONS

From the point of view of the neurological differential diagnosis both of the cases are interesting and instructive The first case was particularly puzzling because of the lack of any history of trauma until the diagnosis had been confirmed by the roentgenogram Before the roentgen findings were reported and the history of the traumatic incident was secured, it was necessary to run through the whole gamut of possible causes of spastic paraplegia After all these had been eliminated, it was only because of the insistence of proper examination of the entire vertebral column in cases of unknown spastic paraplegias that a diagnosis was secured

In the second case the history of the accident was obtained at the outset, yet there were no localizing signs or symptoms to suggest a dislocation of the occiput on the atlas Here again the diagnosis rested upon roentgenologic evidence

The most unusual features of the two cases were (1) the long latent period between the original accident and the onset of the neurological symptoms, and (2) the insidious onset and slow development of the disturbances of the nervous system Nowhere in the literature have we been able to find a case of fracture dislocation in the region of the atlas and axis with such a prolonged latent period One of our

cases began to develop symptoms 18 years after his fall The symptoms started insidiously, progressed very slowly over six years and have remained stationary by clinical tests for the past two years The second patient began to have symptoms four or five years following the accident Her symptoms progressed slowly over a period of a year or so This brings up the question of the pathological process operative in these cases

Several causes for delayed neurological manifestations in fracture-dislocations of the atlas and axis have been described by numerous authors writing on the subject These are, briefly redislocation—Elliott and Sachs (6), Naegeli (7), von Kienböck, *et al*, progressive dislocation—Kahn and Yglesias (8), excessive callus formation—Osgood and Lund (1), Bernstein (4), pachymeningitis and pressure—Blaine (9), myelitis—Jackson (3), irritation of abnormal mobility—Osgood and Lund (1), late development of an osteomyelitis—Osgood and Lund (1)

A study of the histories of the reported cases revealed certain distinct differences between them and our two patients In the former the period of latency varied from several days to eight months In our cases this asymptomatic period was several years In the previously reported cases the development of the neurological symptoms was usually very rapid A few took several months to become complete, but none had the insidious onset and slow progress that we found in our cases

The suggestion of Jackson (3) that a myelitis may develop many years after the accident, and the hint as to the process in the operative observation of thickening of the meninges in the second case suggested to us that we were dealing with some sort of post-traumatic meningomyelitis Circumscribed adhesive spinal arachnoiditis has as its chief characteristic feature an insidious onset, a slow development, and a prolonged progression of the neurological picture This condition has been called by many other names—Cadwalader (10), Wortis (11) The condition consists of

several different gross pathological pictures. There may be arachnoidal cystic formation—Spiller (12), Barré (13), *et al*, adhesions scattered diffusely along the surface of the spinal cord without cyst formation—Stookey (14), masses of arachnoidal adhesions or cysts with more or less ossification, even up to a complete bony plaque, "arachnoiditis ossificans"—Puusepp (15).

The etiological factor in these cases has often been considered to be due to infections elsewhere in the body. However, Armour (16), Foerster (17), Brouwer (18), Mauss and Kruger (19), and others stress the importance of the rôle of trauma in the production of the arachnoidal changes.

The actual pathogenesis of the neurological disturbances has not been definitely determined. In 1926, Stookey (14) considered the adherent arachnoid as anchoring the spinal cord at one point. Because of the normal movements of the spinal cord, he pointed out that a mild trauma was continually exerted at this one fixed point. Thereby, disturbance of cord conduction slowly developed. Others have considered that the arachnoidal and pial proliferations might slowly produce changes in the blood supply of the cord that would result in secondary softenings and degenerations of the conduction systems. In the cystic and ossified forms, direct pressure is the important factor according to Puusepp (15).

That there may be intramedullary changes with a leptomeningitis has been shown by the autopsy findings in a case of Brouwer (18). The chief findings in his case were (1) pachy- and lepto-meningitis, (2) absence of changes in the cells of the gray matter of the spinal cord, (3) a "randmyelitis." He tends to agree with Mauss and Kruger (19) that these changes may well be due to vascular disturbances from arachnoidal adhesions encroaching on the vessels.

The seventh case of Brouwer (18) furnished us with still further evidence as to the process operative in our cases. Because of this we review it here in some detail. A male, aged 37 years, had a severe accident

in which he fractured the base of his skull, several thoracic vertebræ, and certain of his extremities. Nine years later he began to have pain about the umbilicus and down both legs and a burning sensation in his feet. Thirteen years later he noted weakness in the right leg, and in the following year his left leg became weak. The roentgen examination of the vertebræ showed an old fracture in the region of the tenth, eleventh, and twelfth thoracic vertebræ. Eighteen years after the accident the patient presented a spastic paraplegia limited to the lower extremities and definite sensory disturbances below the level of the umbilicus. A Queckenstedt test revealed only a slight block. This was localized by means of lipiodol. A laminectomy was performed, and at the level of the eleventh thoracic vertebræ the surgeon found a circumscribed pachymeningitis. The under side of the dura was smooth. The arachnoid was darkened, edematous, and gelatinous. It separated easily from the spinal cord, which appeared normal. The diseased meninges were removed and the patient recovered remarkably well. His pain disappeared and his locomotion improved so that he was able to walk about with the aid of a stick. The patient remained well for three years. He then began to have pains in his legs and about his anal region, though his ability to walk was not greatly altered from his previous state. Lumbar puncture showed partial block and the patient was treated with diathermy.

It would seem, therefore, that the neurological picture of these two cases of fracture dislocation in the region of the atlas and axis may well be explained on the basis of the development of a post-traumatic spinal arachnoiditis in the cervical region.

DISCUSSION

Neurological syndromes of this type suggest investigation of the atlanto-axial region. In one of our cases the roentgenographic evidence stood alone as a diagnostic aid, and the significant history of injury was not elicited until after insistent

direct inquiry, although a complete systemic review and past history had been previously obtained

The second case illustrates the possibility of failure in demonstration of the essential pathology by the routine roentgen examination, and serves to emphasize the value of repeated study when other causes of the obscure neurological findings are not revealed

There are many difficulties inherent in the anatomical features of the upper cervical region. It is necessary, therefore, for the radiologist to be meticulous in such examinations

Decalcification of the odontoid process may occur at the site of the fracture probably as a result of a fibrosing osteitis. In suspected fracture of the dens the roentgen examination should be repeated in three months. We have seen fracture without displacement which was not detected until the roentgen examination revealed the rarefied appearance of absorption. This zone becomes more pronounced in old fractures, especially if the patient has had no fixation of the neck following the injury. Callus formation does not occur

Fracture of the dens in adolescence may simulate the appearance usually found in developing bone. Therefore, one should exclude the appearance of an epiphysis which normally occurs at the base of the epistropheus

The radiologist and neurologist should be conversant with the possible development of latent manifestations because of its importance in compensation cases

SUMMARY

Two cases of fracture-dislocation in the region of the atlas and axis are reported. Neurological manifestations occurred after a lapse of 18 years in the first and five years in the second

Emphasis is placed upon the fact that in all uncertain cases of spastic paraplegia, even without a history of trauma to the neck, or without local signs, and although the nervous symptoms and signs are far

removed in time from a known injury, thorough roentgen examination of the atlanto-axial region should be performed

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NON-TRAUMATIC DIAPHRAGMATIC HERNIA

WITH A REPORT OF A CASE OF CONGENITAL RIGHT-SIDED HERNIA

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A LARGE number of diaphragmatic hernias have been reported in the literature, in the past 26 years, and it is quite noticeable that the number has markedly increased in the last decade due to the increasing number discovered by routine roentgenologic examinations. Prior to the past ten years, the literature concerning congenital hernia was largely limited to cases found at autopsy or incidental findings during abdominal operations. By far the greatest number reported were due to trauma. The percentage of right-sided hernias reported is very small compared with those found on the left side.

Kerr and Steinberg, in reporting three cases of right-sided hernias, cited Eppinger, whose series of 635 cases of diaphragmatic hernia included 55 hernias of the right side, or about 9 per cent. These cases were based on figures of v Thoma, Locker, Grosser, Wolf, v Grossnitz, B Schmidt, and Iselin.

Hedblom, in listing the locations of hernial openings in 728 cases including his own and those specifically mentioned in the collected series of Lacher, Grosser, Richards, Greenwald, and Steiner, shows about 12 per cent of the non-traumatic to be right-sided.

Eight thousand autopsies at Johns Hopkins Hospital, reviewed by James White, disclosed only one case of right-sided hernia. Breckoff, in reviewing the German literature, found only two cases previously reported and adds his own case. Carman and Fineman, in 1924, reported 20 cases of non-traumatic hernia, all through the esophageal hiatus, discovered in 1,800 examinations. Truesdale reports a case of right-sided hernia in a boy of five, unsuccessfully operated on by Aue, of Leipzig, in 1920. Wilham G Herrman reports an

interesting case in which the pyloric end of the stomach and the duodenum were herniated through the right foramen of Morgagni. Remo Porta (Milan) reports a case of right-sided hernia which he believes was congenital, although it was not proven by autopsy or operation.

Dodds and Pocock, in reporting a right-sided diaphragmatic hernia in a baby living but 30 minutes after birth, cites J C Latta, who reviewed 127 cases of diaphragmatic hernia in which number the age was given in 112 cases. Of this number, 88 were still-born or died within a few hours after birth. The same authors refer to Popp, who reported 42 cases of hernia, only five of which were on the right side.

The only case we could find in the literature similar to the one we are reporting was a case of hernia of the colon and omentum through the right foramen of Morgagni, reported by Hedblom. In addition to the hernia, our case has unusual congenital anomalies.

Etiology—There are five morphologically weak spots in the diaphragm through which congenital or acquired hernias usually occur: right and left parasternal openings (foramen of Morgagni), the right and left pleuroperitoneal openings (foramen of Bochdalek), and the esophageal hiatus (Fig 1). In addition to these normally weak areas, there may be a congenital absence of part or all of the diaphragm. A study of the embryological development of the diaphragm makes clear the possible points of herniation. C Latimer Callander in his text book of surgical anatomy states briefly and clearly the development of the diaphragm, and we quote him *verbatim*:

"The diaphragm arises from five morphological elements—the central tendon, two ventrolateral, and two dorsal parts. The cen-

tral tendon is formed from the transverse septum, an embryonic layer of tissue separating the heart from the liver. The ventrolateral

distress, cyanosis, and dyspnea. Symptoms may simulate ileus, peptic ulcer, gall-bladder disease, heart and lung pathology

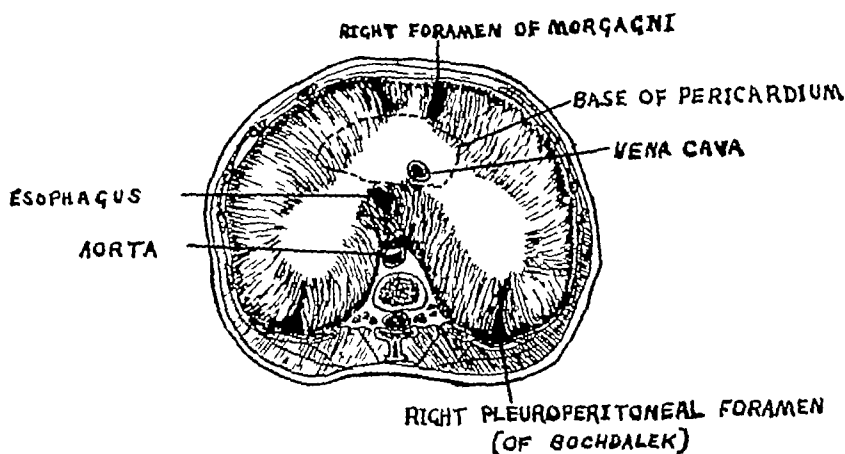


Fig 1 Thoracic view of the diaphragm showing the relative positions of some of the "weak spots" through which the usual congenital hernias occur

portions of the diaphragm arise from the ventrolongitudinal muscle layer of the body. The dorsal portions are derived from the paravertebral musculature. These segments fuse and leave a pleuroperitoneal foramen on each side posteriorly between each dorsal and corresponding ventrolateral part. These apertures close early in fetal life by a fusion of their margins."

We may, therefore, expect to find a hernia at any point along the line of fusion of the anlagen. The question as to whether a hernia is congenital or acquired may in some cases precipitate an academic debate, however, authors in general agree that the congenital hernia is present at birth and generally has no sac, and the acquired develops because of a congenital weakness and generally has a sac. With the presence of a morphological weakness, the contributing causes of acquired hernias may consist of anything which greatly increases the intra-abdominal pressure, such as pregnancy, violent coughing or vomiting, straining at stool, intestinal obstruction, weight-lifting, falls, blows on the abdomen, etc.

Symptomatology—The symptoms may be vague and confusing. We have listed a few of these cited in the literature, as follows: eructations after eating, epigastric pains, colic and burning, nausea, cardiac

There may be a very large defect in the diaphragm without any clinical symptoms. Truesdale refers to Newcomet, who reported a case of congenital hernia in a young athlete who had a large portion of his intestinal tract in the thorax, yet did not complain of serious trouble till he was 17. The diagnosis was not made till two years later when it was revealed by roentgenologic examination.

Roentgen Diagnosis—Non-traumatic hernia is rarely diagnosed without the aid of the x-ray. Fluoroscopic and film examinations without contrast media may suggest the diagnosis. The "intestinal pattern" in the lung-field may be conclusive evidence. The barium meal and enema, with the patient in different positions on the tilting fluoroscopic table, probably give the most useful information. Our routine in gastrointestinal examinations is to scrutinize the thorax first, and then have the patient swallow about two ounces of thick paste composed of barium and water. The writer has often seen the value of this paste demonstrated in visualizing diverticula of the esophagus and herniation of the fundus of the stomach through the esophageal hiatus. It is also better than the fluid meal in studying the rugæ. A meandering esopha-



Fig 2



Fig 3

Fig 2 Showing stomach and duodenum pushed toward the left and rapid emptying after the barium meal

Fig 3 Ten-hour examination

gus, one which gives you the impression that it is longer than normal, may prove to be a hernia of the cardiac end of the stomach through the esophageal hiatus. Often when the head of the table is lowered, as was suggested by Carman, the viscus may be gently forced through the hernial opening. If this procedure were carried out routinely, probably more cases of hernia would be discovered during the usual gastro-intestinal examinations.

Differential Diagnosis—(1) Eventration (paralysis of part or all of one side of the diaphragm) often may be confusing. Sante suggests the use of pneumoperitoneum to locate the position of the diaphragm. Kirklin points out that in eventration the contents of the stomach show a level at the hiatus, while in hernia it is apt to be above it. Dickson says that defective embryologic development of the hepatic flexure may simulate eventration. Hans Fritsch cites some of the diagnostic points in a report of a case. (2) Congenital absence of the diaphragm. This appears to be of academic importance only because

it represents a total defect in development instead of a partial defect as in congenital hernia. (3) Cardio-esophageal relaxation often noted by Kirklin, who cites a report of 100 cases by Robin and Junkelson. (4) Diverticulum of the esophagus and the thoracic stomach as listed in reporting a case by Elward. (5) Lung cysts, bronchiectases, hydropneumothorax, subdiaphragmatic abscess, and echinococcus cysts of the liver and the lung. (6) Openings caused by malignancy and tuberculosis.

The case we are reporting is interesting because of its rarity and its successful treatment.

Case Report—A N, white female, aged 41, referred by Dr J E Laroche, of Berlin, N H. Family history was irrelevant. No history of injury. Mother of 12 children, living and well. Four years ago, she gave birth to a dead fetus by breech presentation, and the labor was difficult. She had pertussis and pneumonia in early childhood. Health since childhood was good till about two years ago. Menstruations normal. Constipated for

several years Patient was referred to the hospital two years ago for Graham test The gall bladder functioned normally

At this time, she was referred to the hospital for gastro-intestinal examination to rule out peptic ulcer She was complaining of dyspepsia, pain in epigastric and right hypochondriac regions, eructations of gas, and a feeling of distention after meals No nausea Slight loss of weight due to restricted diet Patient said that she was comfortable as long as she did not eat The week prior to entering the hospital, her diet consisted of fluids only

Physical Examination—Well-nourished, sthenic type, white female Temperature, 98, pulse, 72, respiration, 20, blood pressure, 140 systolic, and 70 diastolic Head (including ear, nose, throat, and mouth) normal except for edentulous jaws Urine, blood count, blood urea and sugar, normal, van den Bergh test negative Right thorax showed limited respirations, and tympanites over base of lung Heart normal Pain and tenderness in upper right abdomen

Roentgen Examination—Fluoroscopic examination of the thorax showed restricted excursions and irregular outline of the right diaphragm The lung-fields were clear except for increased density above the irregular and indistinct right diaphragm The heart and mediastinum appeared normal The stomach and duodenum were pushed toward the left (Fig 2) The stomach was normal except for hypermotility and hyperperistalsis The ten-hour examination (Fig 3) showed the colon completely filled, with part of the transverse portion in the anterior right thorax The colon was pushed to the left and downward by what appeared to be an enlarged liver, extending below the crest of the ilium The barium enema gave additional information by showing what took place when the colon was well distended (Fig 4) The heart and lower mediastinal structures were displaced to the left while the patient was supine At this point in the examination the patient complained of severe pain and difficulty in breathing Much less of

the gut was seen above the diaphragm while the patient was standing The ileocecal valve was incompetent



Fig 4 Barium enema Shows displacement of heart and lower mediastinal structures toward the left

Surgical Findings and Treatment—The operation was performed by Dr Larochelle A costo-marginal incision was made on the right side extending from the zyphoid process to the eleventh cartilage Muscles were incised and the peritoneum opened As soon as the abdominal cavity was opened, a portion of the colon began to recede from the hernial opening All of the omentum and the rest of the colon were easily delivered with slight traction The opening, about an inch and a half in diameter, was through the foramen of Morgagni There were no signs of adhesions or scar tissue There was no hernial sac The liver was ptosed and rotated about ninety degrees so the left lobe extended into the right pelvis (Fig 5) The usual diaphragmatic surface of the liver was completely covered with peritoneum The suspensory ligament was represented by a long delicate string of peritoneum The size of the liver was normal The gall

bladder appeared normal. The hernial opening was closed by purse-string sutures of silk and covered by mattress sutures

an anomalous suspensory ligament, and no fixation of the hepatic and splenic flexures. There was no history of unusual trauma

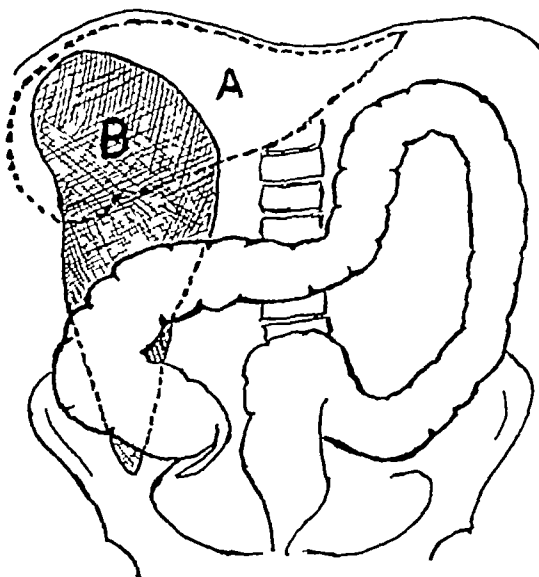


Fig 5 Diagram showing the position of the liver (B) as it was found at operation. Left lobe is in the right pelvis



Fig 6 Barium enema given three months after the operation

No attempt was made to change the position of the liver. The patient was dyspneic and cyanotic for three or four days after the operation, otherwise, the clinical progress was uneventful, and she was discharged well at the end of 18 days. The patient was examined three months after the operation. She had had no recurrence of her symptoms, and the x-ray examination was negative (Fig 6). There was no evidence of atelectasis or diaphragmatic adhesions.

Discussion—Reports of non-traumatic hernia of the right diaphragm are rare and in the majority of cases the condition has been found at autopsy or during abdominal surgery. Most of the cases reported are of infants. Some writers explain the rarity of this type of hernia as being due to the liver acting as a "buffer" during intra-abdominal pressure. Hedblom and others claim that this is not an adequate explanation. We believe this case to be congenital because there was no hernial sac, no adhesions, no scar tissue. There was an anomalous position of the liver with

Twelve normal pregnancies and one difficult labor might lead one to consider them as etiologic factors, however, one must consider the fact that there were no clinical symptoms till two years after the last childbirth. There were no unusual clinical symptoms following pertussis. The anomalous position of the liver offers no difficulties. It is not unusual for congenital defects to cause clinical symptoms only after middle life.

Summary—We have reviewed some of the literature on diaphragmatic hernia with special reference to right-sided non-traumatic types.

A report of a congenital right-sided diaphragmatic hernia through the foramen of Morgagni and unusual congenital anomaly of the liver.

The roentgenologic and surgical findings, and treatment.

The writer wishes to acknowledge his indebtedness to Dr J E Larochelle, of

Berlin, N H, for his surgical notes, and to the laboratory assistants for their kindness in collecting the laboratory and history data

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CASE REPORTS AND NEW DEVICES

AN UNUSUAL CASE OF HODGKIN'S DISEASE OF THE LUNG

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From the Department of Radiation Therapy and the Laboratories of Pathology, Bellevue Hospital

The involvement of the lung by Hodgkin's disease is well recognized, and its pathologic and roentgenologic features have been reviewed in several recent papers (1-4). The following case appeared to be of unusual interest, since the limitation of clinical signs to the lungs for five years suggested a pulmonary origin of the disease. The roentgenologic features of the case were reported by one of us (S R) in

CASE REPORT

J W, aged 42, white, a meter worker, American, complaining of pain in the region of the left shoulder, was admitted to the Radiation Therapy Service of Bellevue Hospital in June, 1932. His illness had begun two years previously, with the simultaneous occurrence of a dry hacking cough and a dull ache in the lower dorsal area which radiated to the left scapular region and the left shoulder. These symptoms persisted for two years without aggravation. He neither coughed blood nor had night sweats. During the four months prior to admission he had lost 15 pounds.

He appeared well developed and well nourished. There was dullness and numerous



Fig 1 (upper left) Jan 8 1932
Fig 2 (upper right) Aug 3 1932 after 3 200 r
Fig 3 (lower left) Aug 26 1932
Fig 4 (lower right) Sept 2 1932 after 3 200 r

1934 (5). The nature of the lesion was then unknown, but it has been subsequently established by biopsy and necropsy

coarse bronchial râles in the left upper chest heard posteriorly. The Wassermann reaction was negative, and the blood count was entirely

normal. A radiograph had been taken elsewhere in January, 1932, which showed a homogeneous decrease in illumination of the upper half of the left lung field, slight elevation of the left dome of the diaphragm, and widening of

decrease in density of the mass (Fig 2). Although fibroid pulmonary tuberculosis was then suspected, several sputum examinations failed to disclose the presence of tubercle bacilli.

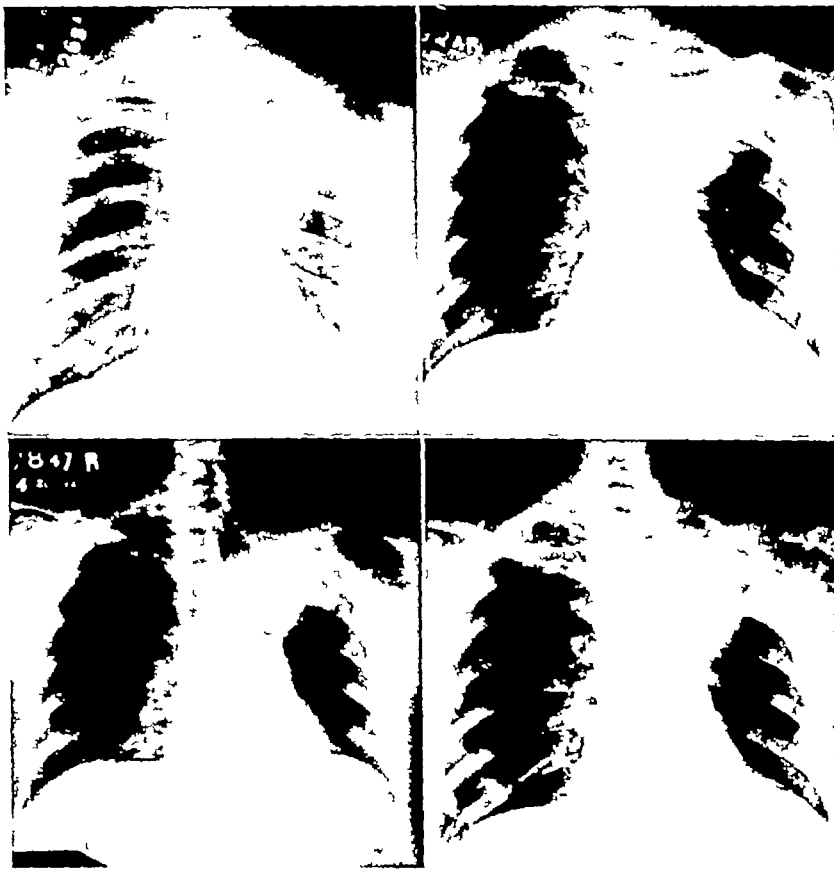


Fig 5 (upper left) Feb 20, 1933
 Fig 6 (upper right) July 6 1933 after 1,600 r
 Fig 7 (lower left) Jan 25, 1934
 Fig 8 (lower right) April 4 1934, after 2,400 r

the mediastinum to the right (Fig 1). On bronchoscopy, the left upper bronchus was found plugged with thick tenacious exudate; after its removal, a normal mucosal surface was disclosed. A bronchogram disclosed failure of filling in the left upper lobe.

In the absence of tissue biopsy, a clinical diagnosis of lung carcinoma was postulated and x-ray therapy was instituted. With 200 kv 4 ma, using an open cone at 40 cm distance, directed to the left lung anteriorly and posteriorly, 1,600 r was administered to each area.

Two months after the completion of this first series of treatments, the patient exhibited remarkable clinical improvement, and a radiograph taken at this time showed pronounced

decrease in density of the mass (Fig 2). Since the initial reaction was so satisfactory, another series of high voltage x-ray was administered in September, 1932, attacking the same areas and employing the same factors. At the end of this second series, a radiograph disclosed additional resolution of the tumor mass, with widening of the mediastinum and marked retraction of the trachea to the left (Fig 4).

In February, 1933, there was a recurrence of the pain in the left chest and shoulder. The x-ray examination disclosed again a dense mass in the left upper chest, with tracheal retraction (Fig 5). The area was again irradiated, giving 800 r as previously. Three months later, in April, 1933, the pain was entirely gone and the patient's general condition

remained good. However, the x-ray film of July, 1933 (Fig 6), presented no striking alteration.

During the next six months the patient did not return to the clinic, being free from all

addition, showed evidence of cavitation (Fig 7). Treatment was again instituted, giving 1,200 r to the anterior and posterior upper chest. Again, the tumor mass resolved, the shoulder pain subsided, and improvement in the general



Fig 9 (upper left) June 15 1934
 Fig 10 (upper right) Oct 5 1934
 Fig 11 (middle left) Dec 21 1934 after 2,400 r
 Fig 12 (middle right) Mar 13 1935 after 2,400 r
 Fig 13 (lower left) April 1935
 Fig 14 (lower right) May 6 1935

symptoms. He re-appeared in January, 1934, when the dull shoulder ache returned. The x-ray film was similar to previous films but, in

condition occurred, although there was no significant change in the x-ray films (Figs 8, 9, and 10).

The Summer of 1934 found the patient absolutely symptom-free. In October a non-productive brassy cough appeared, and was accompanied by palpitations and an afternoon fever of 100° . In December, the left scapular

each area on the anterior and posterior chest walls. Remarkable improvement occurred, with a gain of seven pounds in weight and disappearance of symptoms. The roentgenographs showed slight reduction in the size of

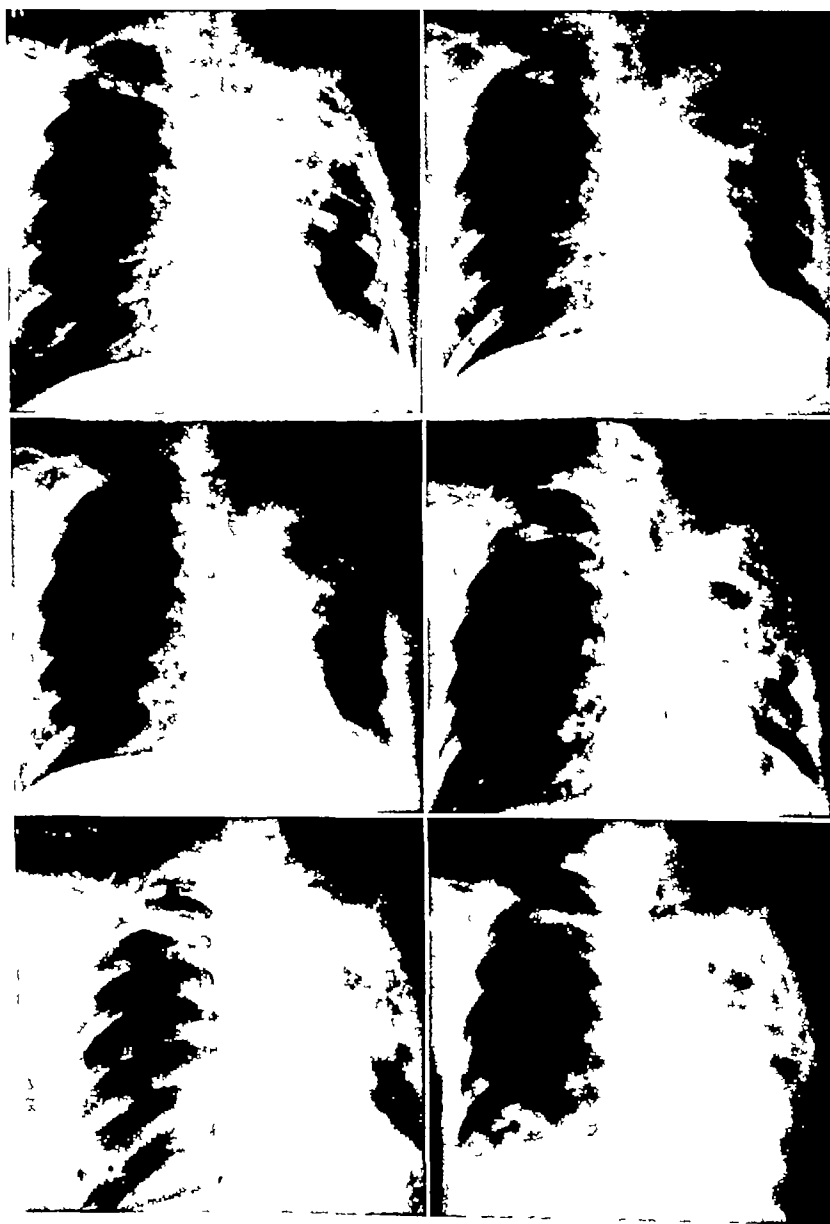


Fig 15 (*upper left*) June 5 1935
 Fig 16 (*upper right*) July 31 1935
 Fig 17 (*middle left*) Aug 20 1935
 Fig 18 (*middle right*) Dec 20 1935, after 2,400 r
 Fig 19 (*lower left*) Feb 10, 1936
 Fig 20 (*lower right*) Aug 7 1936

pain reappeared, and by February, 1935, the patient had lost 17 pounds. At this time, x-ray therapy was again instituted, giving 2,400 r to

the mass, but retraction into the left lung became more pronounced after this series (Fig 11). Then a diffuse haziness appeared in the

remained good. However, the x-ray film of July, 1933 (Fig 6), presented no striking alteration.

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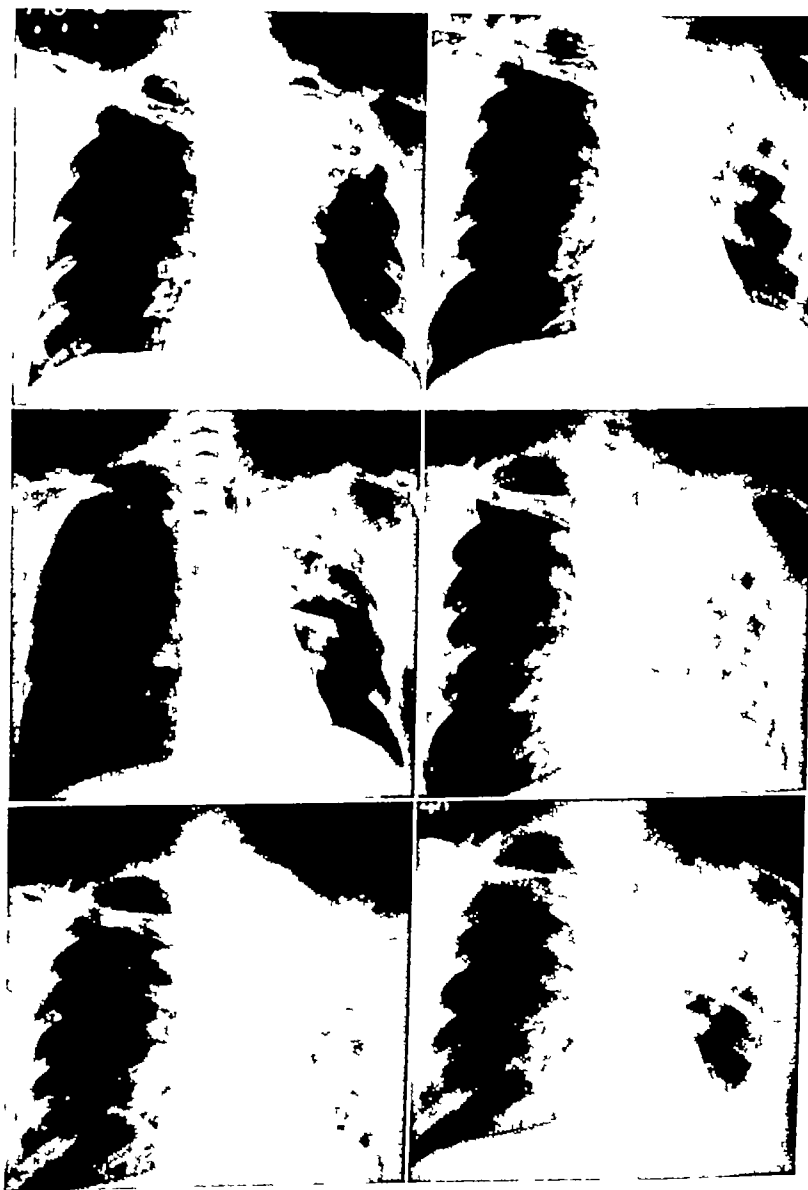


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in size and presented a uniform firm grayish-white character

The liver weighed 200 gm and presented a well-circumscribed grayish-white nodule about 1 cm in diameter situated in the right lobe. Three similar nodules showing central ulceration were found in the mucous membrane of the jejunum.

The rib marrow was red, but the vertebral bodies presented a striking gray appearance on section.

MICROSCOPIC FINDINGS

Lymph Nodes—The normal elements of the nodes are replaced by tissue which varies widely in its cellular content and degree of fibrosis and hyalinization. The cellular pattern is pleomorphic and exhibits the following elements: mononuclear and multinucleated giant cells, eosinophilic and neutrophilic polymorphonuclear leukocytes, lymphocytes, plasma cells, histiocytes, and fibroblasts. The dominant cell varies in different fields and in many fields the giant cells appear particularly numerous. There are occasional foci of amorphous eosinophilic necrosis. The degree of fibrosis is most marked in the mediastinal nodes.

The nodules in the right lung, liver, and jejunum, and the vertebral marrow present a histologic picture similar to the lymph nodes.

Lungs—Sections taken through the fused parietal and visceral pleura of the left lung exhibit dense fibrous tissue without cellular structure. The subjacent lung is made up of dense fibrous tissue containing a few epithelial-lined spaces, an occasional patch of intact alveoli, dilated and atrophic bronchi and bronchioles, and thickened blood vessels. In these fibrous areas are found groups of large mononuclear cells, lymphocytes, multinucleated giant cells, eosinophiles, and histiocytes.

Final Pathological Diagnosis—Hodgkin's disease of the left lung with nodular involvement of the right lung, liver, and jejunum, generalized involvement of the lymph nodes and vertebral marrow, indurative atelectasis, and fibrosis of the left lung, with bronchiectasis and cavitation, fibrosis of the left pleura and acute fibrinous pericarditis.

DISCUSSION

Evidence that Hodgkin's disease may reveal itself most prominently in organs other than the lymph nodes, the associated lymph node enlargements assuming a secondary rôle, has been presented by Symmers (6). Versé (7), in a review of the lesions of the lungs in Hodgkin's disease, noted pulmonary involvement in 29

out of 73 cases. Predominant pulmonary involvement in Hodgkin's disease has been frequently reported (2, 3, 7, and 8), but convincing proof of the pulmonary origin of the disease exists in only three instances. In Altmann's (9) case the process was limited to the bronchi and lungs. Weber (10) reported a case with exclusive pulmonary involvement, and another in which only the lungs and hilar nodes presented the lesions of Hodgkin's disease. In the other reports, although the initial clinical evidence of the disease was pulmonary, and the lungs remained predominantly involved, conclusive evidence of the pulmonary origin is lacking when generalized Hodgkin's disease is disclosed at necropsy.

Although it is similarly impossible to establish with certainty the primary nature of the pulmonary involvement in the case herein reported, the limitation of the clinical phenomenon to the left lung for a period of five years offers suggestive evidence of the pulmonary origin of the disease. Our experience with this case illustrates the confusion which may arise and lead to a diagnosis of lung tumor or pulmonary tuberculosis, when involvement of lymph nodes, spleen, or liver is absent. The dramatic response to roentgen therapy furnishes valuable evidence in the differential diagnosis.

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entire left chest and persisted for two months (Figs 12, 13, and 14)

This latter series of treatment was followed with another less intense dose of 1,200 r to the anterior and posterior chests

The next five months were uneventful. In November, 1935, there appeared sharp shooting pains in the right hip radiating down the thigh, and the brassy cough recurred. A roentgenogram of the bony pelvis revealed no pathologic changes. Treatment was given as previously, a dose of 1,800 r to the chest, anteriorly and posteriorly, and 1,300 r to the pelvis. The pain was soon relieved, and the cough moderated. At this time, facial pallor became evident, and blood analysis revealed a red blood cell count of 3,350,000 with 60 per cent hemoglobin. Following liver therapy, the count was 4,360,000 and the hemoglobin was 75 per cent.

A more dismal picture was evident in February, 1936, when weakness, loss of weight, cough, palpitations, and pain in the leg were again pronounced. Two transfusions were given within a month without effect. Edema of both legs and in the digits of the left hand made its appearance. In June, superficial adenopathy was noted in the neck and in the groin. The nodes were hard, discrete, fixed to the deeper structures, but not to the skin. Fever recurred and pruritus appeared. The diffuse haziness of the entire left chest reappeared (Figs 19 and 20).

A biopsy of a cervical node was performed in August. The node presented, on histologic examination, a loss of normal architecture. There was a diffuse densely cellular infiltration of mononuclear and multinucleated giant cells, lymphocytes, and eosinophilic leukocytes. There were many areas of fibrosis and hyalinization.

Irradiation of the nodes at this stage proved futile. The patient sank rapidly, and succumbed in September, 1936, four years after admission to the hospital, and six years after the onset of the illness.

In brief, a 42-year-old man presented radiographic evidence of a mass in the left upper lobe which successively produced pain in the shoulder, cough, loss of weight, and fever. The mass exhibited a remarkable degree of radiosensitivity which was the deciding factor in altering a clinical diagnosis of lung cancer. Five years after the onset of the illness, superficial adenopathy appeared suggestive of Hodgkin's disease.

Significant Necropsy Findings—The subject appeared pale and poorly nourished. Discrete firm lymph nodes, varying from 1 to 6 cm in diameter, were palpated in the neck, axilla, and groin. The abdomen and right pleural



Fig 21 View of the cut surface of the left lung, the arrow points to the cavity in the upper lobe

cavity contained about 200 cc of clear amber fluid.

The left pleural cavity was obliterated by dense adhesions and the left lung was removed by stripping the parietal pleura from the chest wall. The lung appeared about half its natural size and was enveloped by a dense pearly white membrane which measured up to 1 cm in thickness (Fig 21). The two lobes were densely adherent, and were dense and rubbery in consistency. The cut surface of the entire left lung presented a mottled grayish-white and black appearance with many dilated bronchi and bronchioles, and a thick-walled odorless cavity, about $4 \times 3 \times 2$ cm, was encountered in the posterior portion of the upper lobe.

The right lung was natural except for the presence of several well circumscribed firm grayish subpleural nodules up to 1 cm in diameter.

The mediastinal lymph nodes were discrete and enlarged, but none exceeded 2 cm in size. They appeared firm and grayish-white, a caseous focus was seen in one, a calcified focus in another.

The heart exhibited an acute fibrinous pericarditis.

The retroperitoneal, mesenteric, iliac, inguinal, and femoral nodes varied from 1 to 8 cm

in size and presented a uniform firm grayish-white character

The liver weighed 200 gm and presented a well-circumscribed grayish-white nodule about 1 cm in diameter situated in the right lobe. Three similar nodules showing central ulceration were found in the mucous membrane of the jejunum.

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A more dismal picture was evident in February, 1936, when weakness, loss of weight, cough, palpitations, and pain in the leg were again pronounced Two transfusions were given within a month without effect Edema of both legs and in the digits of the left hand made its appearance In June, superficial adenopathy was noted in the neck and in the groin The nodes were hard, discrete, fixed to the deeper structures, but not to the skin Fever recurred and pruritus appeared The diffuse haziness of the entire left chest reappeared (Figs 19 and 20)

A biopsy of a cervical node was performed in August The node presented, on histologic examination, a loss of normal architecture There was a diffuse densely cellular infiltration of mononuclear and multinucleated giant cells, lymphocytes, and eosinophilic leukocytes There were many areas of fibrosis and hyalinization

Irradiation of the nodes at this stage proved futile The patient sank rapidly, and succumbed in September, 1936, four years after admission to the hospital, and six years after the onset of the illness

In brief, a 42-year-old man presented radiographic evidence of a mass in the left upper lobe which successively produced pain in the shoulder, cough, loss of weight, and fever The mass exhibited a remarkable degree of radiosensitivity which was the deciding factor in altering a clinical diagnosis of lung cancer Five years after the onset of the illness, superficial adenopathy appeared suggestive of Hodgkin's disease

Significant Necropsy Findings—The subject appeared pale and poorly nourished Discrete firm lymph nodes, varying from 1 to 6 cm in diameter, were palpated in the neck, axilla, and groin The abdomen and right pleural



Fig 21 View of the cut surface of the left lung, the arrow points to the cavity in the upper lobe

cavity contained about 200 c c of clear amber fluid

The left pleural cavity was obliterated by dense adhesions and the left lung was removed by stripping the parietal pleura from the chest wall The lung appeared about half its natural size and was enveloped by a dense pearly white membrane which measured up to 1 cm in thickness (Fig 21) The two lobes were densely adherent, and were dense and rubbery in consistency The cut surface of the entire left lung presented a mottled grayish-white and black appearance with many dilated bronchi and bronchioles, and a thick-walled odorless cavity, about $4 \times 3 \times 2$ cm, was encountered in the posterior portion of the upper lobe

The right lung was natural except for the presence of several well circumscribed firm grayish subpleural nodules up to 1 cm in diameter

The mediastinal lymph nodes were discrete and enlarged, but none exceeded 2 cm in size They appeared firm and grayish-white, a caseous focus was seen in one, a calcified focus in another

The heart exhibited an acute fibrinous pericarditis

The retroperitoneal, mesenteric, iliac, inguinal, and femoral nodes varied from 1 to 8 cm

in the colon of patients with constipation of long standing. But this theory cannot be applied to diverticula found in the duodenum and in the small intestines presenting no evidence of stasis. Such deformities are probably due to some congenital factor, their continued enlargement, on the other hand, may be due

A SIMPLE COMPRESSOR

By M J GEYMAN, M D, Santa Barbara, California

We are impressed with the number of imposing and elaborate mechanisms now offered by manufacturers for compression and "spot film" technic. There seems to be a general be-

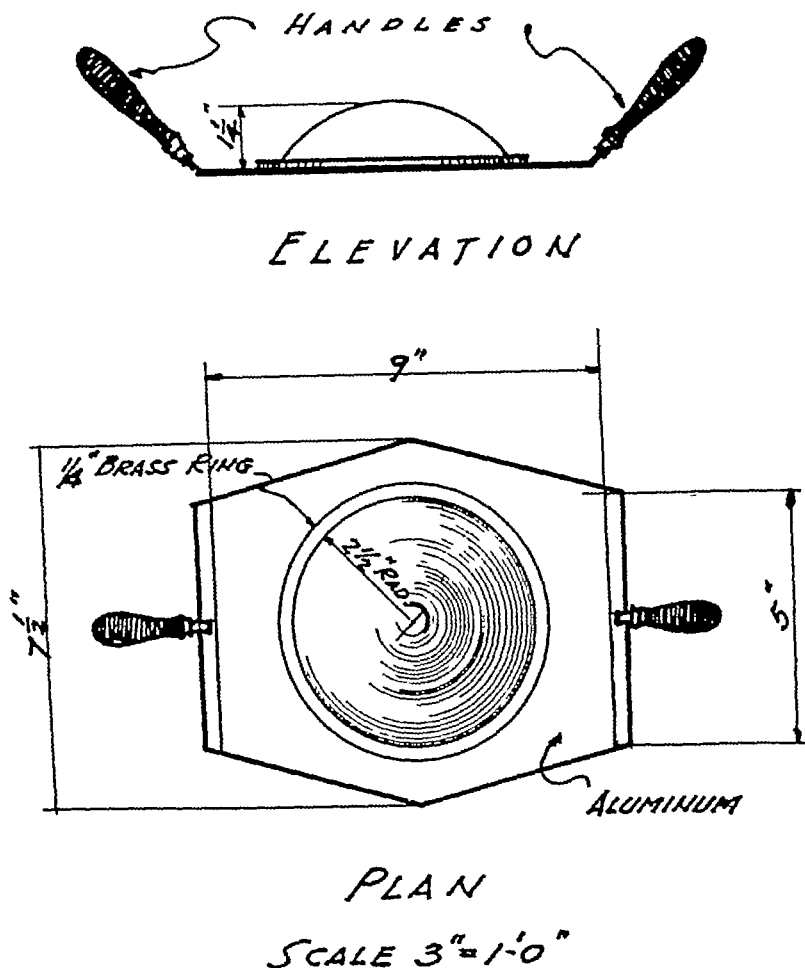


Fig 1 Sketch showing dimensions and shape of a simple compressor

only to stasis of food in the diverticula. The theory of congenital origin can be borne out by data concerning diverticula in the small and large intestines.

The treatment of these cases is of necessity the same as of those with pyloric syndrome. Surgical intervention, however, must take place when the administration of internal medication fails to alleviate the patient's condition.

Summary—A case with multiple diverticula originating in the first portion of the duodenum is reported, and the rarity of such diverticula is discussed.

17 E 89th St

lief among members of the roentgenological profession that an expensive contrivance is necessary to produce "spot films" and pressure studies of gastro-intestinal structures. This is far from true. It is our feeling that many roentgenologists are denying themselves the use of a valuable supplementary procedure because they think the expenditure for new equipment is too great.

Our interest in compression technic was stimulated by the early publications of Akerlund, in which he showed some magnificent films made by a rotating grid mechanism in combination with a bakelite pressure cone. Thinking that all that was necessary to dupli-

MULTIPLE DIVERTICULA OF THE FIRST PART OF THE DUODENUM

By FRANZ J. LUST, M.D., New York City

Diverticula of the intestinal tract are well known, those of the colon being encountered most frequently. However, diverticula of the duodenum are comparatively rare. During our careful analysis of the literature we did not find even a single case with more than two diverticula arising from the first part of the duodenum, we assume, therefore, that our findings may prove to be of some interest.

Case Report—K. S., male, aged 56 years, had vague complaints and discomfort in the right upper quadrant of the abdomen for about fifteen years. He suffered from mild heartburn and gas eructation. Occasionally, he experienced a slight feeling of pressure in the epigastrium. His appetite was good. His bowels moved normally. He never had acute pains or cramps. His weight had been stationary for the past few years. He had no nausea or vomiting.

The patient was well nourished, heart and lungs normal, blood pressure 140/80, abdomen soft, liver and spleen showed no sign of enlargement, no definite tenderness on palpation. On very hard pressure on the right side of the epigastrium he complained of slight discomfort. Stomach contents after alcohol test meal showed slight amount of mucus, free HCl 18, total HCl 32. The stomach contents showed no blood. Examination of the stools, following a meat-free diet of three days, showed no evidence of occult blood. The blood count was normal.

X-ray Examination—Esophagus normal. Stomach filled without delay, in hook form. The lower pole of the larger curvature situated in the interspinous line. The mucosal pattern of the stomach normal. Curvatures normal. Peristalsis increased. The pylorus opened immediately after the peristalsis reached it. The cap was filled readily. From the top of the cap, three small ducts leading into three diverticula, were visualized. The x-ray plates in the upright position showed these diverticula with horizontal fluid level and gas bubbles on top. The second portion of the duodenum was situated behind the antrum, the other part of the duodenum was normal and free from the presence of diverticula. The best view of the diverticula was furnished by the left oblique position. After two hours, a slight residue was observed in the stomach. The diverticula had not emptied, and the remainder of the barium was in the small intestines. After six hours the stomach was empty, and the diverticula were well filled, showing the same



Fig. 1. Radiograph taken in upright position showing the multiple diverticula of the duodenum.

grape-like aspect. The remaining barium was in the ileocecal portion of the intestines. After 24 hours, the diverticula were empty, and there was only a filling of the colon. The treatment of the patient was limited to diet and alkali. The patient's condition improved to a certain extent, but all the complaints were not eliminated. An operation was suggested, but it met with the patient's opposition. A control examination six months later showed findings analogous to those already reported.

Our case presents, as all the other cases of duodenal diverticula, no special syndrome. The patient's complaints are similar to those characterizing chronic ulcer cases, the only existing difference being that the discomfort lasts longer after meals.

These findings suggest the possibility of congenital diverticula to which three types, namely—diverticula in the first, second, and third parts of the duodenum—possibly belong. However, we have no definite proof for the cause or origin of diverticula. Most of them have hitherto been reported in advanced age, so that an opinion generally prevails that they are caused by deficient structure and by weakness of the intestinal wall. This theory was advanced with the first discovery of diverticula.

CONCLUSIONS

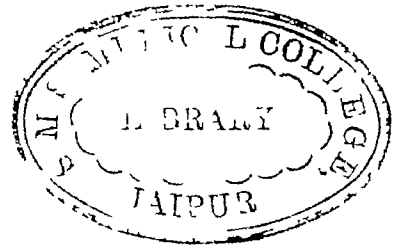
A simple type of compressor is described which, in the hands of an experienced roentgenologist, will produce the same quality of relief studies of the duodenal bulb and portions of the stomach as can be obtained with more elaborate and expensive compression mechanisms. The following factors are essential to produce good compression studies

1 The examiner must be an experienced fluoroscopist

2 Sufficient energy must be available to the fluoroscopic tube to permit short exposures. Most films should be obtained between 0.1 and

0.25 second, more than 0.4 sec. is undesirable and over 0.5 sec. unsatisfactory.

3 Some form of compression device, preferably simple, is desirable, particularly until the examiner is proficient in this supplementary phase of gastro-intestinal study. The compressor described above is made for us by our local hardware dealer, at a cost of three dollars. If expense is no item, the more elaborate devices sold with some of the better combination tables are desirable to have, since they do facilitate the procedure. For details of interpretation and use of compression technic one should read the excellent publications of the original contributors in the European literature and later communications in our own journals.



cate his beautiful work was similar equipment, we immediately acquired one of these very clever devices. While the grid was mechanically ingenious, when it was used with the pressure cone the results left much to be de-

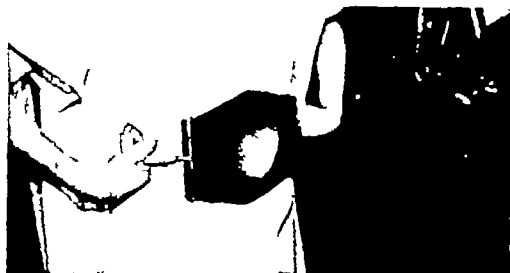


Fig 2 The simple compressor described showing it as held by the patient

sired, even though we had made necessary changes to permit energization of the fluoroscopic tube with sufficient current to permit short exposures. We were forced to discard the grid mechanism and resort to the use of a simple compression medium. Together with various pads and cones, we used a Chaoul compressor, which was more generally satisfactory than our "home made" efforts, but it could not be kept in place, either with the belt provided or with the help of the patient's hands. We, therefore, designed a compressor which is a modification of an aluminum hemisphere used by Rigler after his period of study in Sweden.

Our compressor consists of a strip of aluminum fashioned into a shallow cone. Handles are attached to the flanged sides, and a thin steel ring placed around the margins of the

scopic study of the stomach and cap with the small barium meal, the pressure device is held by the patient, being centered over the desired area (Fig 2). The degree of pressure best adapted to relief study is determined and necessary energy changes made to permit short exposures. The cassette is held against the flat side of the compressor and the exposure is made (Fig 3). On one of our units, after the device is centered, an assistant steps to the control booth and makes the desired setting. It is not absolutely essential that a rapid changing energy control be available to the examiner's hand, as with very little coaching most patients co-operate readily. With each exposure the image of the barium coated duodenal cap or stomach is flashed on the screen, the examiner obtaining a fairly good idea of what the film will show. The smallest possible area of exposure is used. When the diaphragm is cut down to a screen image of 5×5 in or less the lead-gloved hands of the examiner holding two diagonal corners of an 8×10 cassette, are safely out of the harmful radiation zone, as shown by measurements by H J Ullmann in our routine work. A measurement of our fluoroscopic setting gave 13 r m, chamber at table top in center of beam (reading corrected for pressure and temperature). The same chamber (25 r) at the outside edge of the beam on the anterior of the patient's abdomen for one minute gave too little ionization to be read on the scale. Four radiographic exposures with the chamber at the back of the compressor placed on the patient's abdomen also registered too little to be read.

We use the erect position almost exclusively for compression study of the stomach and cap, and have no fears as to the danger of too much pressure in this position, but we do feel there



Fig 3 Cassette against compressor (ordinarily behind fluoroscopic screen)

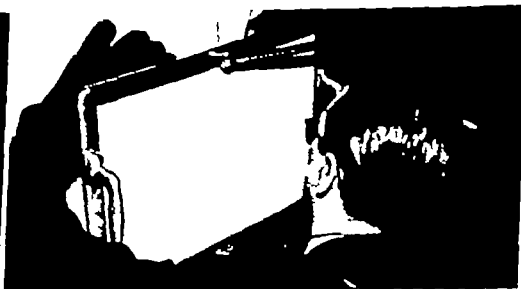


Fig 4 Cassette being held for exposure

dome. The ring provides an opaque circle for centering the pressure dome under the fluoroscopic screen (Fig 1). After the usual fluoro-

is some danger in prone compression as greater degrees of pressure are necessary for good relief patterns.

to May, inclusive, at Wayne County Medical Society Bldg

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Meets with Minnesota Radiological Society

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VERMONT

See New England Roentgen Ray Society

WASHINGTON

WASHINGTON STATE RADIOLOGICAL SOCIETY *President*, H E Nichols, M D, *Secretary*, T T Dawson, M D, Meetings fourth Monday of each month at College Club, Seattle

RADIOLOGICAL SOCIETIES IN THE UNITED STATES

CALENDAR

MEETINGS FALLING BETWEEN THE DATES OF MAY 15 AND JUNE 30

May 18-20 Illinois State Society, Section of Radiology, Peoria, 87th annual meeting

May 19 Connecticut State Medical Society, Section on Radiology, Hartford

May 21-22 Pennsylvania Radiological Society, Erie, annual meeting

Editor's note—Will secretaries of societies please co-operate with the Editor by supplying him with information for this page

CALIFORNIA

CALIFORNIA MEDICAL ASSOCIATION, SECTION ON RADIOLOGY Meets annually with California Medical Association

LOS ANGELES COUNTY MEDICAL ASSOCIATION, RADIOLOGICAL SECTION *President*, D R McColl, M D, *Vice-president*, John F Chapman, M D, *Secretary*, E N Liljedahl, M D, *Treasurer*, Henry Snure, M D Meets every second Wednesday of month at County Society Building

PACIFIC ROENTGEN CLUB *Chairman*, Raymond G Taylor, M D, 1212 Shatto St, Los Angeles, *Secretary*, L Henry Garland, M D, 450 Sutter St, San Francisco

COLORADO

DENVER RADIOLOGICAL CLUB *President*, W Walter Wasson, M D, 246 Metropolitan Bldg, *Vice-president*, Ernst A Schmidt, M D, Colorado General Hospital, *Secretary*, Nathan B Newcomer, M D, 306 Republic Bldg, *Treasurer*, Leonard G Crosby, M D, 366 Metropolitan Bldg Meets third Tuesday of each month at home of some member Midsummer Conference, Shurley-Savoy Hotel, July 15-17

CONNECTICUT

CONNECTICUT STATE MEDICAL SOCIETY, SECTION ON RADIOLOGY *Chairman*, R H Lockhart, M D, 144 Golden Hill St, Bridgeport, *Secretary-treasurer*, Max Clman, M D, 242 Trumbull St, Hartford Meeting, May 19, Hartford

DELAWARE

Affiliated with Philadelphia Roentgen Ray Society

FLORIDA

FLORIDA STATE RADIOLOGICAL SOCIETY *Presi-*

dent, Gerald Raap, M D, 168 S E First St., Miami, *Vice-president*, H O Brown, M.D., 404 First Nat'l Bank Bldg, Tampa, *Secretary-treasurer*, H B McEuen, M D, 126 W Adams St, Jacksonville

ILLINOIS

CHICAGO ROENTGEN SOCIETY *President*, David S Beilin, M D, 411 Garfield Ave, *Vice-president*, Chester J Challenger, M.D., 3117 Logan Blvd, *Secretary-treasurer*, Roe J Maier, M D, 7752 Halsted St. Meets second Thursday of each month, September to May, except December

ILLINOIS RADIOLOGICAL SOCIETY *President*, Ivan Brouse, M D, 316 W State, Jacksonville, *Vice-president*, Cesar Gianturco, M D, Carle Hospital Clinic, Urbana, *Secretary treasurer*, Edmund P Halley, M D, 968 Citizens Bldg, Decatur Meetings quarterly by announcement.

ILLINOIS STATE SOCIETY, SECTION OF RADIOLOGY *President*, Roswell T Pettit, M.D., 728 Columbus St, Ottawa, *Secretary*, Ralph G Willy, M D, 1138 N Leavitt St, Chicago Eighty-seventh annual meeting at Peoria, May 18-20

INDIANA

INDIANA ROENTGEN SOCIETY *President*, E M Van Buskirk, M D, 347 W Berry St, Fort Wayne, *President elect*, J N Collins, M D, 23 E Ohio St, Indianapolis, *Vice president*, H H Inlow, M D, 3 W Washington St, Shelbyville, *Secretary-treasurer*, C C Taylor, M D, 23 Ohio St, Indianapolis Meeting May 9, at Indianapolis Athletic Club

MAINE

See New England Roentgen Ray Society

MARYLAND

BALTIMORE CITY MEDICAL SOCIETY, RADIOLOGICAL SECTION *Secretary*, H E Wright, M D, 101 W Read St, Baltimore Meetings each Monday night

MASSACHUSETTS

See New England Roentgen Ray Society

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to May, inclusive, at Wayne County Medical Society Bldg

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THE ROENTGENOLOGIC ASPECT OF CANCER OF THE PANCREAS

It is now appreciated that nearly all of the abdominal viscera lend themselves to roentgenologic diagnosis, most of them by the use of some radiopaque substance or substances. The accuracy with which lesions of the gastrointestinal tract are now being diagnosed with the roentgen ray is fully recognized. Diseases of the gall bladder are readily recognized when that organ is visualized by an opaque dye. The size and shape of the liver and spleen—and often tumors of these organs—have been visualized by the intravenous injection of thorium dioxide, and at times by the introduction of air into the abdominal cavity, certain organs are brought into relief so that a complete study can be made. The roentgen diagnosis of diseases of the genito-urinary tract visualized by opaque medium is a daily procedure. Even the abdominal lymphatics have been visualized with thorium dioxide.

The pancreas remains as one of the few abdominal organs which has not as yet been made to absorb radiopaque substances, and for this reason, it cannot be visualized for direct roentgenologic study. This important organ plays a vital rôle in the maintenance of health, and when diseased, serious consequences often ensue. While we appreciate that cancer of any abdominal organ is serious, the fact that with the roentgen ray disease often may be recognized early, offers some hope for the patient. In the instance of the pancreas, this is not true, as when cancer of the pancreas is recognized it is usually well advanced, due to our inability to visualize the organ.

We have to resort to indirect signs, such as pressure and encroachment on neighboring viscera, for the demonstration of tumor of this organ. In many instances this method of examination is inaccurate and misleading. This should stimulate us to a further study of this organ, with the hope that some means will be found by which it can be studied roentgenologically with greater accuracy.

The literature on the subject reveals some interesting observations made from time to time by earnest workers, using the roentgen ray in their studies. Only a few are mentioned here.

In 1923, Dickson (1) described certain deformity produced on a stomach and duodenum filled with bariumized fluid, which might have been due to cancer of the pancreas. Some time later, Butler and Ritvo (2) called attention to a displacement, with a widening of the duodenal curve as a result of the pressure of a tumor of the head of the pancreas. Rigler (3), in an interesting study, confirmed Butler and Ritvo's observations, namely, that it was possible in a large number of cases of cancer of the pancreas that the duodenal curve was enlarged. But he also observed that in cases in which the neoplasm affected the body and tail of this organ, the stomach was displaced upward and forward, while the transverse colon was displaced downward.

Engel and Lysholm (4), in 1934, described their method of studying the pancreas by distending the stomach with gas, and making lateral films of the patient's abdomen in the prone position. In this manner they were able to demonstrate an enlarged pancreas by the increase in the space which it occupied, and at times a tumor of this organ was seen in relief when its shadow protruded on the gas shadow of the stomach.

In 1935 Borak (5) made use of cholecystography in studying tumor of the pancreas. He observed that in cases wherein the common duct was completely occluded, there was no filling of the gall bladder and no stasis of dye in the colon. But in the early stages, before the common duct had become completely occluded, he observed that the gall bladder was enlarged and also that the shadow produced by the dye remained over a long period of time.

Recently, Paul (6) reported 23 cases of carcinoma of the pancreas, the majority of which gave some evidence of the presence of

the neoplasm when studied by means of a barium meal. In a certain number of cases the roentgen ray could not be relied upon for a diagnosis.

It is evident from a study of the observations made by many investigators in the diagnosis of cancer of the pancreas, that much remains for us to learn. It would appear that at the present time, while the roentgen ray is of value in certain instances in the diagnosis of cancer of the pancreas, reliance should not be placed entirely on this method, but a clinical examination by a competent internist or surgeon should be obtained, in consultation with the roentgen findings, if we hope for earlier diagnosis.

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COMMUNICATION

EXPLANATION OF CHARTS

RECOMMENDED BY THE STANDARDIZATION COMMITTEE OF THE RADIOLOGICAL SOCIETY OF NORTH AMERICA, INC., 1937

The Standardization Committee of the Radiological Society of North America has designed a chart or form for recording roentgen treatments as illustrated. The explanation of these charts has been published in pamphlet form and can be obtained with orders for the charts from D. S. Childs, M.D., Secretary-Treasurer of the Radiological Society of North America, 607 Medical Arts Bldg., Syracuse, New York. Questions which may arise in regard to the correct usage of the forms may be directed to U. V. Portmann, M.D., Cleveland Clinic, Cleveland, Ohio, or any other member of the Standardization Committee.

1. The Standardization Committee of the Radiological Society of North America deems

it advisable to recommend a standard form or chart for recording the factors used in administering treatments with roentgen rays. The general acceptance and usage of this standard form should encourage accuracy in planning treatments and create mutual understanding about the procedures employed by different individuals, thus ensuring uniformity in recording the technical factors, especially in publications when technics are described. After almost two years of study, the Committee has designed a chart form which should be acceptable. It contains all essential data about treatment factors in proper order and convenient spacing.

2. Two forms have been designed to be printed on the standard $8\frac{1}{2} \times 11$ inch page usually used for institutional records and in private offices. The page may be folded in half so that the record will be $4\frac{1}{4} \times 5\frac{1}{2}$ inches to conform to another standard size sometimes preferred. The forms will be obtainable separately or printed together on opposite sides of one sheet of paper or card in a variety of colors. The printed matter may be centered on the page or offset to allow sufficient margin at the left, right, top or bottom for binding or for printing additional data, the names of the institutions or individuals, etc. Thus, these forms can be adapted to almost any sort of record or filing system.

3. Form No. 1 was designed for those who prefer to keep clinical data and the record of treatments on one sheet or card in which case Form No. 2 would be printed on the opposite side of Form No. 1. It may not be necessary to use Form No. 1 in institutions or offices where clinical data are kept in detail or where other accepted record systems are used but it should be a convenient form for private practitioners. The headings for the horizontal lines on Form No. 1 are self-explanatory. It should be noted that provision has been made for recording measurements of the body and disease regions which necessarily must be made when the plans for treating a patient are outlined, in order to pre-determine the quantity of radiation to be administered to different regions. The bottom half of the page is left blank for drawing, stamping, or printing anatomical diagrams. It is suggested that rubber stamp anatomical outlines will be useful for this purpose. They may be obtained through the American Medical Association at reasonable prices, in many varieties and sizes which illustrate different regions of the body. The portals of entry or fields of radia-

tion and the disease regions can be sketched in these outlines quite easily and accurately

4 Form No 2 should be used by all radiologists to comply with the recommendations of the Standardization Committee This form

eases The differences between technics depend largely upon variations in voltages and filters, or more than one apparatus may be used A physicist who is registered by the Standardization Committee should standardize and cali-

STANDARD CHART FOR ROENTGEN THERAPY

NAME:	No
ADDRESS:	
DIAGNOSIS:	
PREVIOUS TREATMENT:	
CLINICAL NOTES:	
DISEASE, LOCATION EXTENT PATHOLOGY:	
DISEASE MEASUREMENTS:	
BODY MEASUREMENTS:	
PLANS FOR TREATMENT:	

Fig 1 Reduced from actual size

provides spaces for recording all essential physical data and their use in giving treatments When this form is used alone, there will be sufficient space at the top or margin in which to have printed any headings desired in addition to lines for the name of the patient, number, and diagnosis The back of the page may be used for anatomical diagrams, for recording measurements of the body and disease regions, or other data which may be desired

5 On Form No 2 the "Calibrated Physical Factors" of technic are arranged in one group and the data concerning their application to the patient in another group under the heading, "Daily Record of Treatment" This arrangement obviates the necessity of writing each day those physical factors which are not changed during the course of treatment of a patient Usually a radiologist will employ several technics for the treatment of different types of dis-

ease Each apparatus for every technic that the radiologist uses A permanent record of these calibrations should be kept for ready reference in book form or charts For convenience, each different technic or set of physical factors should be given individual identification by designation with a letter or number When the radiologist has decided which technic he will employ in the treatment of a patient whose record is being compiled, he will write its letter or number designation and all of the "Calibrated Physical Factors" which pertain to it in the appropriate spaces provided on the form as will be explained

6 Under the heading, "Calibrated Physical Factors," the first column is headed "Tech" (technic) In the first space below should be written the letter or number chosen to designate the technic which will be employed in the treatment of the patient, and the physical factors

which apply to this technic will be written along the first horizontal line in the proper spaces. When this is done, there will be no necessity for rewriting these factors each day that a treatment is given. It might happen that two or even

written in this column. When large ionization chambers are used in the beam of radiation, the copper equivalent thickness should be included as a part of the 'Added' filtration.

13 "Total" This column is provided to

CALIBRATED PHYSICAL FACTORS												
TECH	DESCRIPTION OF APPARATUS	KV	FILTRATION			hvl mm	ma	BEAM SIZE	DIST cm	r/m AIR		
			INHERENT	ADDED	TOTAL							

DAILY RECORD OF TREATMENT																	
DAY	DATE	TECH	REGION TREATED	FIELD SIZE	fsd cm	min	r AIR	QUANTITY ON SKIN				QUANTITY ON DISEASE					
								r/m	FIELD r	EXIT r	TOTAL r	%	r/m	DAY r	TOTAL r		

Fig 2 Reduced from actual size

three different technics would be used in treating a patient. To meet this contingency, three horizontal lines have been provided. If a second or third technic is used, the letter or number designating each should be written in the "tech" column, and the physical factors which apply to each of them should also be written along the horizontal lines in the proper spaces.

7 "Description of Apparatus" Under this heading a brief description of the apparatus should be given, including especially the type of current used—whether pulsating or constant potential—and also the type of tube—whether air-suspended or oil-immersed.

8 The physical factors which have to do with the quality of the radiation are grouped together as headings for the next columns between heavy vertical lines.

9 "kv" (kilovolts) In choosing a technic it is natural first to decide upon the voltage which will be used. Voltage should be designated as 'Peak' or 'Constant' according to the type of apparatus used.

10 "Filtration" Filtration naturally follows kv as a factor influencing quality. Under this heading are columns and spaces for recording the thickness in millimeters of all filters which may be used for the technic employed.

11 "Inherent" Under this heading should be written the copper equivalent thickness of any filtration which is inherent in the tube or tube holder. This applies especially to metal or oil-immersed tubes.

12 "Added" The thickness of any filter which is added to any inherent filter should be

summarize the total amount of filtration which should be expressed in millimeters of the metals used for the technic.

14 "hvl mm" According to international agreement, the quality of a roentgen-ray beam should be expressed by half value layers in millimeter thicknesses of aluminum for low voltages and in copper for high voltage. The correct designation of the quality should be written by appropriate abbreviations in the spaces of this column.

15 The physical factors which have to do with the quantity of radiation are grouped together as headings for the next columns between heavy vertical lines.

16 "ma" is used to indicate the milliamperage used for the technic.

17 "Beam Size" Under this heading is noted the linear size in cm of the beam through a diaphragm or cone used in making the calibrations for the technic. This size may vary during the treatment, therefore in the "Daily Record of Treatment" provision has been made under a heading "Field Size" for indicating any change. Due allowance and corrections should be made for changes in the size of the beam. See paragraph 26.

18 "Dist cm" (distance in centimeters from tube focus to ionization chamber) This distance may be varied in giving the treatment, therefore, in the "Daily Record of Treatment" provision has been made for indicating any change under a heading "fsd cm". Due allowance and correction should be made for changes in distance according to the inverse square law. See paragraph 27.

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			INHERENT	ADDED	TOTAL						

DAILY RECORD OF TREATMENT																	
DAY	DATE	TECH	REGION TREATED	FIELD SIZE	fsd cm	min	r AIR	QUANTITY ON SKIN				QUANTITY ON DISEASE					
								r/m	FIELD r	EXIT r	TOTAL r	%	r/m	DAY r	TOTAL r		

Fig 2 Reduced from actual size

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18 "Dist cm" (distance in centimeters from tube focus to ionization chamber) This distance may be varied in giving the treatment, therefore, in the "Daily Record of Treatment" provision has been made for indicating any change under a heading "fsd cm". Due allowance and correction should be made for changes in distance according to the inverse square law. See paragraph 27.

19 "r/m air" (roentgens per minute in air) This is the output in roentgens per minute of an apparatus according to the calibrated physical factors used for the technic

20 A column has been left blank in which to write other data. The Standardization Committee suggest that the "roentgen value" for the technic be recorded in this column. This factor is determined under the following standard conditions. A standard distance of 100 cm shall be used from the tube focus to a standardized thimble ionization chamber placed in the center of a beam which is delineated by a 10 x 10 cm diaphragm placed 20 cm above the chamber (or 80 cm from the tube focus). Under these standard conditions, the r/m measured in air (back-scattering excluded) gives the "roentgen value" for the other technical factors used.

21 Under the heading "Daily Record of Treatment" are columns, lines, and spaces for recording the data concerning the application of the technic used throughout the course of treatment.

22 "Day" This column is provided for recording the sequence of days or the order in which different regions of the body and fields may be irradiated. The total number of days over which the course of treatment extends will be indicated.

23 "Date" This column is used for recording the date on which any treatment is given. It is suggested that the year number be written immediately under "date" at the head of the column and the month and day numbers in the spaces below.

24 "Tech" (Technic) In this column should be written the letter or number designation of the technic used on the day a treatment is given. It refers to the technic described above under the heading "Calibrated Physical Factors". Example: A theoretical case of a patient with an epithelioma of the lip. The radiologist decides that first he will treat the lesion with a technic which he has chosen to designate by the letter "A," and later to treat the cervical gland-bearing area by another technic which he has designated "C." He will have written in the description of the physical factors for each of these technics under the heading "Calibrated Physical Factors" as previously explained. Then on the days that "A" technic is used, he will write that letter in the "Tech" column in the "Daily Record of Treatment" and likewise he will write "C" in this column on the day he uses this other tech-

nic. This obviates the necessity for rewriting the full details of each technic daily.

25 "Region Treated" The region of the body treated may be indicated by appropriate descriptive names, abbreviations, initials, or numbers as preferred and should refer to anatomical diagrams which have been made showing the fields and disease regions treated, as previously suggested.

26 "Field Size" The size of the field irradiated should be given in linear dimensions in cm of the area on the skin which is irradiated and should not be expressed in square cm. The size of the field may differ from the beam size used in making the calibrations for the technic and therefore the r/m air also will be different. Consequently, due allowance and corrections should be made for changes in the quantity (r/m air) which will result. Note: When oil-immersed tubes are used, it will be necessary to make direct and individual measurements for each change in field dimensions from the "beam size" used in calibrations because of the scattering from the oil in the container.

27 "fsd cm" (Tube focus, skin distance) The focus-skin distance used in treatment may differ from that used in making the calibrations for the technic and therefore the r/m air also will be different. When the distance is varied, due allowance and corrections should be made for the changes in quantity (r/m air) which will result according to the inverse square law. Note: When oil-immersed tubes are used, the inverse square law cannot be applied, therefore it will be necessary to make direct and individual measurements for each change in distance from that distance used in calibrations because of the amount of back-scattering from the oil in the container.

28 "min" (minutes of treatment) represents the number of minutes used for the treatment in order to give the predetermined quantity on the skin.

29 "r air" (roentgens in air) indicates the number of roentgens in air that will be given in the period of time (minutes) over which the treatment is given according to the physical factors for the technic employed and after corrections have been made for any changes in the size of the field or distance.

30 Under the group heading "Quantity on the Skin" are columns for recording the quantity of radiation in roentgens which affects the skin according to the technical factors used. All the calibrations or calculations of quantity which have been made previously have been

based upon measurements made in air. When a treatment is given according to the conditions which have been recorded, a certain amount of back-scattering will affect the skin and this must be taken into consideration. The Standardization Committee is fully aware that the roentgen may not be a true measure for tissue effects according to strict physical criteria and the definition of this unit, however, in practice it is very convenient and satisfactory to express and think of tissue dosage in roentgens. Therefore, in designing this chart, provision has been made for recording in roentgens the quantity of radiation which affects the tissues including direct and back-scattered radiation. It is the practice of some radiologists to measure the quantity on the skin, including direct and back-scattered radiation with standardized thimble ionization chambers placed on the skin in the field and others estimate it on the basis of charts or curves which show the percentage of back-scattering according to the quantity of direct radiation under the technical conditions used for the treatment.

31 "r/m" (roentgens per minute on the skin). This is to express the rate at which the skin is affected. It is the practice of some radiologists to measure this factor directly by placing the thimble chamber of a dosimeter in the skin in the field of radiation and others estimate it on the basis of the roentgens per minute in air with correction for the amount of back-scattering. Example: If the treatment time is 20 minutes to give 200 r air and it is estimated that there is 40 per cent back-scattering, the r/m skin will be calculated as follows: $(200 \text{ r} + 40\% \text{ of } 200 \text{ r}) \div 20 \text{ min} = \text{r/m skin}$
 $200 \text{ r} + 80 \text{ r} = 280 \div 20 = 14 \text{ r/m on skin}$

32 "Field r" (Field roentgens on the skin). This is the total number of roentgens which affect the skin during the treatment. It is the practice of some radiologists to measure this factor directly by placing the thimble chamber of a dosimeter in the skin in the field of radiation and others estimate it on the basis of the roentgens per minute in air with correction for the amount of back-scattering. Example: According to the physical factors of the technic, 200 r air are to be given and, after taking into consideration the field size and volume of tissue, it may be estimated that there is 40 per cent back-scattering. Then the "Field r" will be $200 \text{ r} + 40\% \text{ of } 200 \text{ r} = 280 \text{ r}$.

33 "Exit r" (Exit roentgens on the skin). This column shows the amount of radiation in

roentgens that affects an area on the skin of the side of the body opposite to that being treated. This quantity must be taken into consideration when this opposite area is to be used as a field in the course of treatment and must be added to the amount which is received subsequently. The exit r usually has been estimated from isodose charts, curves, or tables which show depth absorption measurements that are applicable to the technical conditions used for the treatment. While such methods do not give accurate values for the exit dose, they give a reasonable approximation which may be used in practice until better information is available. Example: A pelvis is to be treated through the suprapubic and sacral fields which are $20 \times 20 \text{ cm}$ square and the pelvis is 20 cm in the anterior-posterior diameter. The suprapubic field is to be given 250 r on the first day. Under the technical conditions employed, the absorption curves might show that 15 per cent of the amount on the surface reached a depth of 20 cm. Therefore, from the suprapubic field, the sacral field would receive 15 per cent of 250 r or 37.5 as the "exit r". In recording the "exit r" the number should be written on the horizontal line used to record the data concerning the region of the body to which it applies. Thus, in this example, it was the sacral field which received the "exit r" and the amount which it received should be recorded on the horizontal line which will apply to the sacral area. The suprapubic field will not receive exit radiation until the sacral field is treated, then the "field r" and "exit r" in each area will be added together to give the "total r" as will be explained.

34 "Total r" (Total roentgens on the skin). The total quantity of radiation in roentgens which affects the skin of any field will be the "field r" (including direct and back-scattered radiation) plus any "exit r" which it may receive from another field. Example: As in the previous example, a suprapubic area is given 250 r on the first day and this number will be recorded in both the "field r" and "total r" columns because this area has not yet received any "exit r". However, the sacral field receives 37.5 (15% of 250 r) from the suprapubic field and therefore 37.5 exit r will be recorded on the horizontal line which will apply to the data concerning the sacral field when it is treated. On the second day the sacral field also is given 250 field r. Therefore, the "total r" which the sacral area will have received will be $37.5 \text{ r} + 250 \text{ r} = 287.5 \text{ r}$ on this second day.

The opposite suprapubic field also will have received the same amount on the second day

35 A blank column has been provided in which to record other data about the quantity on the skin which may be desired. In designing those forms, no provision has been made for indicating *per diem* tissue losses or for keeping a record according to "saturation" technique. Those who prefer to keep their records according to this plan may use this blank column for recording the estimated percentage *per diem* losses or may keep any other charts which they prefer in addition to this standard form.

36 The objects of recording the quantity on the skin according to this plan are (1) to insure taking into account all of the radiation which any area receives, (2) to be able at any time to ascertain the amount that any area has received to date, and (3) to be able to determine without any other calculations when a pre-determined or skin tolerance quantity has been given. These objectives are reached quite easily by summing up from time to time the total amount which already has been given or by keeping a running total of the amount of radiation which has been given to each field at preceding treatments in the "total r" column. There are two methods for keeping the running totals.

First method. As each field is treated, the record is kept in the sequence in which treatment is given and the amount which has been administered previously is added to that given on the day of treatment. By keeping this running total for each field from day to day, there is no necessity for adding the total r at another time because the amount already given on each area will be indicated at all times and when the predetermined quantity or skin tolerance is reached the treatment may be discontinued.

The second method. When planning the course of treatment for the patient, the radiologist decides how many fields he will use and the amount which he expects to give on each. Then he may allow a certain number of horizontal lines in sequence for each field and either keep a running total or add the "total r" for each field from time to time until the pre-determined amount is reached.

37 The heading, "Quantity on disease" gives a record of the amount of radiation that is applied in the disease tissues.

38 "% (per cent). This is the percentage of the surface radiation that reaches the center

of the disease region as estimated on the basis of absorption isodose curves, charts, or tables. Example: It may be found that 50 per cent of the surface dose reaches to the depth of the center of a disease region. The number 50 will be written in the "% column.

39 "r/m" (roentgens per minute) shows the rate in roentgens at which the disease is treated and is comparable to the "r/m" rate on the skin. Example: If 10 r/m might be given on the skin and 50 per cent reached the depth of a disease area, then (50 per cent of 10) 5.0 r/m would be the rate on the disease. There are indications that in the future it may be desirable to treat different types of disease at different rates, and therefore records should be kept which will be desirable for reference in this regard.

40 "Day r" (Day roentgens) is the estimated quantity of radiation in roentgens that the center of the disease region receives on the day of treatment. This is comparable to the "field r" in the "quantity on skin" heading. The number of roentgens is estimated according to the percentage of the skin dose which reaches the depth of the disease. Example: If 250 roentgens are given on a skin field and 50 per cent reaches the disease, the "daily r" to this area will be 125 roentgens.

41 "Total r" (total roentgens) shows the total quantity of radiation in roentgens which reaches the center of a disease region through all the portals which may be used. This may be recorded as a running total in the same manner as the "total r" on the skin was recorded. Example: If on the first day of treatment, 250 roentgens are given on the skin and the disease area receives 50 per cent of this or 125 roentgens as recorded in the "Daily r" column, then on the second day the same treatment and amounts are given through another portal, the disease region will have received a "total r" of (125 r + 125) or 250 r. In this manner it is easy to record the estimates of how much radiation was applied to a particular disease region. From clinical observations of the results obtained, conclusions may be reached about the efficacy of this amount of treatment and what quantity of radiation is necessary to eliminate different types of disease.

42 Blank columns are provided to be ruled and headed according to the wishes of the radiologist, for names or initials of radiologists, or technicians or for other data.

The standard order forms may be obtained from D S Childs, M D, Secretary-Treasurer, Radiological Society of North America, 607 Medical Arts Bldg, Syracuse, New York

IN MEMORIAM

JAMES JOHN QUINEY

1881-1937

James John Quiney, M D, of Easton, Pa, died at his home March 31, after a short illness. He gave up general practice in 1922 to specialize in roentgenology and radium therapy. Dr Quiney, who was a member of the Radiological Society of North America, was past president of the Pennsylvania Radiological Society and of the Philadelphia Roentgen Ray Society. Professionally he was also affiliated with the Lehigh Valley Medical Society, Pennsylvania State Medical Society, American Medical Association, Philadelphia College of Physicians, American Roentgen Ray Society, was a fellow of the American College of Radiology, and president of the Northampton County Medical Society. He attended Jefferson Medical College at Philadelphia.

BOOK REVIEWS

AMERICAN MARTYRS TO SCIENCE THROUGH THE ROENTGEN RAY. By PERCY BROWN, M D, F A C P, F A C R, Historian and former President of the American Roentgen Ray Society. A volume of 276 pages. Published by Charles C Thomas, Springfield, Illinois. Price, \$3 50.

That the roentgen rays took a heavy toll of suffering and death among the first American workers with this amazing form of energy is well known, but few persons, including many present-day radiologists, fully realize how long is the roll of sacrificial pioneers or how significant were their accomplishments. Yet not less than twenty eight of those who blazed the path for roentgenologic advance in this country paid for their devotion with their lives and left behind as an enduring monument the facts they won so dearly, the fundamental truths that we of to day accept so casually.

The roll Dally, Ascheim, Weigel, Fuchs, Egelhoff, the brothers Wagner, Kassabian, Thomas, Early, Leonard, Baker, Green, Bauer, Dodd, Ghadden, Caldwell, Morehouse, Roberts, Sims, Machlett, Swett, Morrison, Baetjer, Pit-

kin, Satterlee, Kraus, and Parker. A majority were physicians, some were electrical engineers, technicians, or artisans. All added something, great or small, to roentgenologic science and art. All still live in the recollection of older radiologists, and even to younger practitioners many of the names will have a familiar sound.

Of each, Percy Brown has told the story—an interesting and different story of the contributions that each one made—a pathetic and similar story at the end. Every radiologist who has the slightest interest in the history of his profession should have the book.

DIAGNOSTIC ROENTGENOLOGY. Edited by ROSS GOLDEN, M.D., Professor of Radiology, the College of Physicians and Surgeons, Columbia University, Director of the Department of Radiology, Presbyterian Hospital, New York. A volume of 854 pages (loose leaf). Published by Thomas Nelson and Sons, New York, 1936. Price, \$20 00.

American text-books relating to roentgenologic diagnosis have been limited chiefly to monographs concerning special subjects and to short concise books written primarily for students. Because of the great advances in roentgenology and its close relation to all the branches of medicine the subject has become too formidable for any one man to attempt to write a comprehensive treatise of the subject. Dr Golden has solved this problem in a most practical manner by compiling a loose leaf system of diagnostic roentgenology in which the various chapters, which can be revised as time demands, are written by various authors who have acquired a reputation for special work in the field concerned.

The first edition of this loose leaf system consists of eleven chapters which cover the most important fields of roentgen diagnosis. They are as follows:

Diseases of the Skull and Intracranial Contents	C G Dyke
Examination of the Nasal Sinuses and Mastoids	G W Grier
The Chest	C B Rabin
Digestive Tract	R Golden
Diseases of Bone	P C Hodges, D B Phe-
	mister, A Brunschwig
Spinal Cord Tumors	C G Dyke
Urinary Tract	L Jaches M L Sussman
Uterotubography	S A Robins, A A Sha-
	pira
Obstetrics	H C Moloy P C Swen-
	son
Fractures	E H Skinner

All of the chapters are extensively illustrated.

and present the fundamental diagnostic criteria for that particular subject, some more completely than others. As a whole this volume represents the most comprehensive consideration of the subject of roentgenologic diagnosis that has yet appeared in the English language. The book is obviously written primarily for the general practitioner, student, and less experienced radiologist, and for this group it should have a great appeal. Even the experienced radiologist can learn much from this book but those who are interested in a thorough and comprehensive consideration of any particular subject will still find it necessary to refer to special monographs and the more inclusive foreign texts. Undoubtedly subsequent revisions and additional chapters will greatly enhance the value of this highly commendable addition to the roentgenologic literature.

GEFÄSSMISSBILDUNGEN UND GEFÄSSGESCHWULSTE DES GEHIRNS (Congenital Vascular Anomalies and Vascular Diseases of the Brain) By PROF. DR. H. BERGSTRAND, Direktor des Instituts für Allgemeine Pathologie und Pathologische Anatomie des Karolinischen Instituts in Stockholm, PROF. DR. H. OLIVECRONA, Direktor der Neurochirurgischen Klinik in Stockholm, and PROF. DR. WILHELM TÖNNIS, Leiter der Neurochirurgischen Abteilung des Staatlichen Luitpoldkrankenhauses in Würzburg. A volume of 181 pages, 137 illustrations. Published by Georg Thieme, Leipzig, Germany, 1936. Price, bound, 26 RM.

This comprehensive and detailed consideration of congenital anomalies and diseases of the vascular system of the brain is written by three authors, each of whom is well known for his contributions to this subject. The text is arranged in seven chapters. The first chapter by Tönnis is a short introduction, Chapter II by Bergstrand concerns the pathologic anatomy of hemangiomas of the central nervous system. The following conditions are discussed together with case histories, photographs of gross specimens, drawings and roentgenograms: angioma cavernosum, angioma racemosum (five varieties), angioretikulomas, angioblastomas, Lindau tumors and angiogliomas. In Chapter III Olivecrona presents a review and classification of the clinical material. Chapter IV by Olivecrona relates to Sturge-Weber's disease which is thoroughly discussed by means of case histories, operative findings, roentgenograms,

and arteriograms. Tönnis in Chapter V discusses in detail arterio-venous aneurysms and presents numerous interesting arteriograms. Chapter VI, also by Tönnis, relates to racemose venous angiomas. In Chapter VII Olivecrona discusses the pathologic anatomy, incidence, symptomatology, diagnosis, and treatment of angioretikulomas.

This outstanding text will be of interest to all neurologists, neurosurgeons, and neuroroentgenologists. To the roentgenologist it will illustrate in a very excellent manner the great value of intracranial arteriography in revealing the character and extent of vascular lesions of the brain.

TRAITE DE CHIRURGIE ORTHOPEDIQUE (Volume I, in five volumes) By L. OMBREDANNE, Professeur de clinique chirurgicale infantile et orthopedie à la Faculté de médecine de Paris, membre de l'Académie de médecine, chirurgien de l'hôpital des Enfants-Malades, and P. MATHIEU, Professeur de clinique de chirurgie orthopedique de l'adulte à la Faculté de médecine de Paris, chirurgien de l'hôpital Cochin. A volume 902 pages, 433 illustrations. Published by Masson et Cie, Paris, 1937. Price, 300 fr.

This is the first volume of a five-volume work edited under the supervision of these authors, both of whom are outstanding surgeons. The scope of the work is exhaustive, covering almost every known phase of orthopedic work. In the General Table of material in Volumes I to V, given in this volume, the outline shows that the subject has been taken up in anatomical sequence, as follows:

Part I. Physiology, pathology, and general therapeutics, Part II. Spine and superior extremity, Part III. Pelvis and inferior extremity, Part IV. General technic.

Volume I, with which this review is concerned, covers congenital malformations, affections of the bones, affections of the joints, surgical operations of bones and joints, affections of the muscles, tendons and aponeuroses, and affections of the skin.

A glance through the list of collaborators shows that they have all been selected from the leaders of orthopedic surgery in France. For this reason the work is strongly French in its scope and character and may be said to represent the up-to-date views of orthopedic surgery as seen in France to-day. We do not mean to imply that the viewpoint of other countries has

not been given—most of the important works from other countries are duly mentioned and emphasized. The bibliographies, however, are not as complete as some would like to see in a work of this size and scope.

The work is well arranged and the style excellent. The reproductions of photographs and x-rays are excellent. In the section on "Osteosynthesis" several types of internal fixation, not commonly used in the United States, are illustrated and described. The elaboration of this type of fixation has become so great that one must hesitate to accept all of the various types recommended if for no other reason than that they complicate rather than simplify the treatment of fractures.

In general, the subject matter covers all the various ramifications of orthopedics and as a general review of the subject it is obviously well done. The subject of orthopedic surgery has developed so much that many phases of surgery, which a few years ago would have no place in orthopedics, are to-day recognized as parts of orthopedic surgery in many parts of the world. From this standpoint the work is well conceived. Almost every phase of surgery in which an orthopedist can be interested is touched on.

With the publication of the other volumes many points briefly touched on in this volume may be elaborated, at least we hope so. We are sure of the need of such a complete presentation of the subject as is here undertaken. It will be a useful reference system in any surgeon's library, whether or not he is devoting his time entirely to orthopedics.

Köhler. That section of the book relating to the osseous system makes up nearly one-half of the volume and reflects the author's deep interest in roentgenology of the skeletal system, for which he is best known. This part in itself will remain as a fitting monument to a keen observer and a wise teacher.

Succeeding editions of this work have grown in size, not so much by contributions from the original author as by the addition of much heterogeneous material from the literature, largely of European and British origin, that is intended to widen the appeal of the text. In its present form the book suffers greatly from the effects of careless or injudicious editing since no attempt has been made to delete former statements and references to work that has long since been disproved by subsequent observations. The inclusion of such information is dangerous for students and quite misleading to those who are inclined to believe much of what they read, especially in a well-known volume of this type. No consistent system has been followed in the format of the bibliography and many important and informative American references have been omitted. In the growth from one edition to another the author's original purpose has been lost sight of and the present volume takes on more the make-up of a text-book of general diagnosis rather than a presentation of the borderlands of the normal and early pathological as originally intended.

It is hoped that this book will soon be entirely revised and re-edited in the light of our present knowledge so it may again become a safe and informative reference for students, practitioners, and radiologists.

ROENTGENOLOGY—THE BORDERLANDS OF THE NORMAL AND EARLY PATHOLOGICAL IN THE SKIAGRAM. By ALBAN KÖHLER, Prof Dr Medizin, Wiesbaden. Second revised English edition. Translated and edited by ARTHUR TURNBULL, M A, B Sc, M B, Ch B, E, demonstrator of Anatomy, University of Glasgow. A volume of 681 pages, 100 illustrations. Published by William Wood & Company, Baltimore, Maryland, 1935. Price, \$14 00.

This is the second English edition of a unique text-book of roentgenologic diagnosis, which in previous editions achieved probably more international popularity than any other book concerning the subject. The basic parts of the text are founded on the thirty-odd years' personal experience and observations of Professor

DAS VENTRIKULOGRAM. By ERIK LYSHOLM, Dozent für Medizin Radiologie, and BERTIL EBENIUS and HANS SAHLSTEDT, Assistenten am Röntgeninstitut, Seraphimerkrankenhauses, Stockholm. Part I—RÖNTGENTECHNIK. Supp XXIV, Acta Radiologica, 74 pages, with 74 illustrations. Published by P A Norstedt & Sons, Stockholm, Sweden, 1935. Price 10 Sw cr (\$2 80), paper cover.

This is the first of a series of monographs concerning ventriculography that are being prepared by Dr Lysholm and his associates in the Röntgeninstitut of the Seraphimerkrankenhauses in Stockholm. Dr Lysholm is well known in Europe for his contributions to

neuroroentgenology and the ingenious devices that he has developed for a more efficient roentgenologic examination of the skull

The first part of the monograph is devoted to a consideration of the anatomy of the intracranial cerebrospinal spaces, a knowledge of which is fundamental to an intelligent interpretation of ventriculograms. The second chapter, written by Sahlstedt, concerns the normal ventriculogram and is illustrated by numerous ventriculograms and drawings. The third chapter, by Ebenius, concerns the principle of the interpretation of ventriculograms. The fourth chapter is a comprehensive description of the technic of ventriculography by means of Lysholm's skull apparatus. Each of the authors' standard positions are illustrated by photographs of the patient and the corresponding roentgenogram. The structures revealed by each position are enumerated. The concluding chapter concerns the technic of examination for ventriculography with iodized oil, here also photographs of the patient in various positions and the corresponding roentgenograms are shown.

This concise presentation of the technic of ventriculography is the most valuable and informative consideration of the subject that has yet appeared. It is indispensable to anyone who is interested in performing ventriculography efficiently and interpreting the results intelligently. The text is short and concise and those who do not read German will find an English translation to be a worthwhile investment.

DAS VENTRIKULOGRAF By ERIK LYSHOLM, Dozent für Medizin Radiologie, and BERTIL EBENIUS and HANS SAHLSTEDT, Assistenten am Röntgeninstitut, Seraphimerkrankenhäuser, Stockholm. Part III—THIRD AND FOURTH VENTRICLES. Supplement XXVI, Acta Radiologica, 124 pages. Published by

P. A. Norstedt & Sons, Stockholm, Sweden, 1935. Price 12 Sw cr (\$3.36), paper cover.

This is the third of a series of monographs concerning ventriculography that have been prepared by Dr. Lysholm and his associates in the Röntgeninstitut of the Seraphimerkrankenhäuser in Stockholm. Those who are fortunate enough to possess the first part of this series of monographs will readily appreciate the wealth of information that is contained in this volume. The authors have subdivided the lesions affecting the third and fourth ventricles into eleven groups according to their anatomical location. These are enumerated as follows:

- 1 Anterior part of the third ventricle and foramen Monro
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The ventriculographic characteristics for each group are enumerated and the diagnostic signs are illustrated by typical roentgenograms and tracings. The conclusions are based on a large group of cases which have been studied with the meticulous technic for which Dr. Lysholm and his associates are well known.

This small concise monograph contains more practical information concerning the ventriculographic findings in lesions affecting the third and fourth ventricles than can be gained by a review of all the literature concerning the subject. Like the preceding volumes in this series, the text is in German, however, it is not long and a translation should not be difficult.

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GEORGE E BURCH, JR, M D, of New Orleans, La.	WILLIAM R STECHER, M.D, of Easton, Pa
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ABSCESS, PULMONARY

The Treatment of Pulmonary Abscess with Alcohol Injection. E Magnus-Alsleben, Salâhi Durusoy, and Serif Atakam Schweiz. med. Wchnschr., Dec 12, 1936, 50, 1262-1264

Convincing reports and excellent roentgenograms are presented depicting the amazing resolution of typical pulmonary abscesses by the intravenous injection of alcohol (33 per cent—given every fourth day in amounts of 200 c c). In six cases, five were completely cured clinically and as shown anatomically on the roentgenograms. No untoward effects were noted. The working method of the alcohol in the pulmonary tissue is difficult to comprehend from a purely antiseptic standpoint, the most likely theory is the rapid oxidation thereof, with production of acetaldehyde which might act much like formaldehyde on tissue.

WILLIAM R. STECHER, M D

APPARATUS

Filters for the Infra red and Red Spectral Region O Merkelbach Strahlentherapie 1936, 57, 689

The author studied and analyzed filters available for the infra red and red spectrum. He classifies filters suitable for experimental work in this region and offers definite recommendations for their selection.

ERNST A. POHLE, M D, Ph D

BONE DISEASES (DIAGNOSIS)

Osteogenesis Imperfecta (Vrolik Type) and Osteospathyrosis Idiopathica (Lobstein Type) E Glanzmann. Schweiz. med. Wchnschr., Nov 14, 1936, 46, 1122-1126

Osteogenesis imperfecta (Vrolik's mucromelia) commences in fetal life, after the seventh month. The new born presents the following features: markedly foreshortened long bones, which are thickened and plump in appearance. There are generally concomitant multiple fractures which heal readily, and many showing abundant callus formation. The skull is enlarged, giving the impression of a small face. Palpation of the calvarium affords pathognomonic "gum-ball" impression with isolated areas of firm osseous tissue. The fontanels and sutures are abnormally wide. The sclera are very blue in appearance due to transparent sclera and shining through of retinal pigment. The fingers of the outstretched arm do not reach the iliac crest and the bowed lower extremities approximate an O-shape, which appearance is accentuated with incident equino-varus deformity. The prognosis is very poor, most cases being born dead. Occasionally a four-year survival occurs.

The roentgen findings are characteristic, showing diffuse cortical bone thinning, haziness of spongiosa

structure, with intensified calcium deposition in the temporary zone of calcification of epiphyses. The ribs are widened and show bowed deformities, infraction, and healing. The entity is not hereditary. An interesting observation is the high thrombocyte count (500,000), together with slightly increased inorganic serum phosphorus content of the blood. There is assumedly insufficient osteoblast formation which accounts for the lack of normal ossification.

Osteospathyrosis (Lobstein Type—fragilitas osseum) —These cases are apparently born normal, relative to skeletal proportions. The leading sign is the great tendency to fracture, even with the slightest trauma. The most frequent time of presentation of symptoms is from seven to 11 years of age. There are frequently subperiosteal fractures, but ample callus formation is likewise the rule. The bones are slender and gracile in appearance, often presenting bowing which occurs near the mid-diaphyseal region rather than at a juxta-epiphyseal site as in rachitis. There is increased radiolucency of the osseous structure roentgenographically, with thinned diaphyseal compact bone, and relatively transparent epiphyses. The temporary zone of calcification is unaltered and the epiphyseal line is not widened. The skull strongly resembles the natifurmo caput as observed in osteogenesis imperfecta. The blue sclera is slightly different than the type that occurs in osteogenesis imperfecta, there being a violet hue. Of importance is the finding of progressive deafness, due to otosclerosis. The hair becomes thin and brittle, and there are deformed finger and toe nails. There is a thrombocytosis and slight eosinophilia, but no hemorrhagic diathesis is definable. There is slight lowering of the blood phosphorus content, much as in rachitis. The osteoblastic activity is similarly diminished and reduced. The prognosis is good, and after 20 years of age there is a definite remission of tendency toward fracture. The differential diagnosis between osteospathyrosis and rickets is not difficult, as is that of scorbutus. Therapeutically, thyroid and parathyroid glandular extracts have been given, together with vitamins C and D.

The question whether these two types of Vrolik and Lobstein are merely forms of an identical disease is discussed. Many features in common are present in these two entities and the supposition is that in the case of osteogenesis imperfecta the disease is so severe that it is incompatible with life whereas the Lobstein type is the *forme frusle*. The histopathology would seem to engender this theory of identical diseases wherein a dynamic dysfunction of the osteoblasts is present. The cardinal difference is the time of development, osteogenesis being a distinctly fetal disease. It is questionable and debatable whether or not mild forms of osteogenesis imperfecta later in life eventuate as osteospathyrosis (Lobstein). The weight of opinion is against this supposition, which is further maintained by the lack of hereditary character of osteogenesis imperfecta in contradistinction to the very definite hereditary factor in osteospathyrosis.

WILLIAM R. STECHER, M D

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cancer, and the fostered example of the lessened incidence of malignancy in the southern climes is explainable on the basis of a shorter span of life rather than the effect of vitamins, etc. Experimental evidence has also proved this, in the case of inoperable malignancies in which this treatment was instituted, and in which no salubrious results were obtained for it is impossible to conduct such rigid dietary experiments as to make this method practical

WILLIAM R. STECHER, M D

Radiotherapeusis of Malignancy in Combination with a New Organic Iodine Compound K Kottmann Schweiz med Wchnschr, Nov 14, 1936, 46, 1145-1148

A synergistic attempt of combined radiotherapy and a substance administered in the endeavor to increase the radiosensitivity of malignant cells is proffered. The preparation employed is iod naphthol disulfo acetate. The material is administered orally and intravenously. A case history is cited, in which hilar lymphogranuloma presented complete resolution with no evidence of recurrence over a period of one and one-half years. However, no biopsy or other indisputable proof was obtained, and incidentally, such remissions occasionally occur with roentgen therapy alone. Experimental work conducted upon mouse carcinoma and chondroma showed favorable results with combined therapy. A case of carcinoma solidum, involving the mediastinum, showed complete disappearance of compression signs and symptoms. Ordinarily this type of malignancy is very resistant to radiotherapy. The author stresses the fact that further observations upon a large group of cases must be made before the method can be properly evaluated.

WILLIAM R. STECHER, M D

DOSAGE

Measurements on Soft Roentgen Rays (Chaoul Technic) W V Mayncord Strahlentherapie, 1936, 56, 660

The author presents the results of his thorough investigation of roentgen rays produced at 60 kv, to be used at a distance of from 3 to 5 cm. The findings are demonstrated in 11 graphs. A new type of dosimeter, used for these measurements, is described. Spectrographic and absorption studies showed that the radiation had an average wave length of 0.32 Å. The output corresponded to about 25 r per minute per ma of tube current. Data are also given regarding backscatter, depth dose percentage and distribution of radiant energy in water.

ERNST A. POHLE, M D, Ph D

Problems of Radiation Therapy with Ultra high Potentials T Leucutia Strahlentherapie 1936, 56, 633

This is a brief discussion of some of the physical, biological and clinical problems in x ray therapy with

potentials over 200 kilovolts. While it is too early at this time to predict the future development of this super-high voltage technic, the author is convinced that an increase of the potential to from 400 to 600 kv or above will give better clinical results in certain cases (See also Am Jour Roentgenol and Rad Ther, 1934, 31, 628, also 1935 34, 664)

ERNST A. POHLE, M D, Ph D

ENDARTERITIS OBLITERANS

Roentgen Therapy of Endarteritis Obliterans P Cottenot Strahlentherapie, 1936, 56, 569

The author saw good results in the treatment of endarteritis obliterans with roentgen rays. Exposure of the peripheral lesion as well as of the respective spinal ganglion seems to be effective. In both instances 200 r were given three times per week up to a total of from 1,000 to 1,200 r (130-140 kv, 5-8 mm Al).

ERNST A. POHLE, M D, Ph D

THE EYE

X radiation of the Blind Glaucomatous Eye W Kreibitz Wien Klin Wchnschr, July 3, 1936, pp 843-845 (Reprinted by permission from the British Med Jour, Oct 10, 1936, p 59 of Epitome of Current Medical Literature)

The author favors, in all cases of painful eye with absolute glaucoma (of whatever causation), a trial of treatment by x radiation—three small doses of 50 r every third day, with repetition, if necessary, at several intervals of one to two weeks. In a minority there is no response, and enucleation must be done. As a rule, however, there is disappearance of pain, which must be due to action on the sensory ocular nerves, for usually no reduction of tension follows. Irritative signs are not produced by this fractional therapy.

THE FOOT

Genesis of Epithelioma by Kukirol A W Busse München med Wchnschr, July 31, 1936 31, 1269

A case of squamous-cell epithelioma of the dorsum of the toe is presented as a resultant from chronic irritation of medicament applied for relief of clavus.

WILLIAM R. STECHER, M D

Total Dislocation of the Astragalus Joseph I Mitchell Jour Bone and Joint Surg, January, 1936, 18, 212-214

The author reports a case of lateral and anterior dislocation of the astragalus. The dislocation was reduced under spinal anesthesia by closed manipulation. It was believed that the injury occurred when the patient's shoe heel caught on a step as she slipped on the ice thus causing her to fall down four steps.

J N ANÉ, M D

BREAST CANCER

Primary Mammary Carcinoma in the Axilla Hermann Matti Schweiz med Wehnschr, Nov 21, 1936, 47, 1159

Ectopic mammary tissue or glands can occur anywhere along the "milk ridge," which extends from the axilla to the inguinal region, also, rarely in arm, shoulder, or back. A nipple may or may not be present, and tumefaction occurs synchronously with a normal physiologic process of other breasts. There is a much greater tendency for malignant change in ectopic mammary glands, and its early diagnosis is made difficult, mainly, by absence of pain, absence of indications of the possibility of mammary carcinoma, and suggestive findings of tuberculous lymphadenopathy. To further complicate matters a therapeutic test of irradiation is not diagnostic, as some degree of regression is noted in both instances. It is emphasized that coincident mastectomy of the adjoining seemingly normal breast is advisable, for rapid direct extension of the malignant process is the rule and occurs early. It is not unusual for the process to remain latent for several years, with sudden activation and rapid spread to the lymphatic tissue, particularly about the vessels in the axilla.

WILLIAM R. STECHER, M D

BURSITIS

Treatment of Subacromial Bursitis by Roentgen Irradiation Isidore Lattman Am Jour Roentgenol and Rad Ther, July 1936, 36, 55-60

Twenty cases of subacromial bursitis are presented in which roentgen therapy has been employed. The results justify the belief that roentgen therapy will relieve pain and restore function more rapidly than other methods of treatment. Many others were treated with equally good results, but were not followed from one to five years as were those reported.

One treatment of 350 r to the anterior or posterior shoulder with 200 kv, 0.25 Cu, 50 cm distance and field 15 X 15 cm suffices although at times two treatments are required. The factors 140 kv, 5 ma, Al mm 5 15 X 15 cm field 16 cm distance 20 min, have also been employed. During the first 24 hours the symptoms may be aggravated, but within the next 24 hours improvement begins.

The etiology pathology anatomy symptoms, differential diagnosis, and treatments are reviewed.

S M ATKINS M D

In a survey of 69 cases, the test was correct in only 72.5 per cent, and the author concludes that to-day one must consider the clinical methods of examination far more important and reliable than serum diagnosis. He makes a plea for honest and sincere evaluation of any sero-diagnostic tests for malignancy, for only in this way will there be dispelled prejudice such as might accrue from unwarranted, over enthusiastic claims which have been presented in the literature.

WILLIAM R. STECHER, M D

Etiologic Factors of Bronchial Carcinoma. R. Fleckseder München med Wehnschr, Sept 25, 1936, p 1585

A careful review of 63 cases of bronchial carcinoma has lead the author to the following deductions. In all cases there is a history of prior pulmonic and particularly bronchial damage or infection, and of the many cited causes pulmonary tuberculosis and involvement of the hilar and peribronchial lymph nodes causing bronchial pressure are mentioned as of greatest importance. Other factors, particularly atherosclerosis syphilis, and chronic lead poisoning, associated with hypertension, are mentioned as causes. In females there is an additional endocrine factor which manifests itself in the climacteric, however the relatively few females presenting bronchial carcinoma lends weight to the argument that this disturbance acts indirectly in the form of vascular changes. There was a startling percentage of cases showing habits of excessive smoking, particularly of cigarettes which could act dually in causing direct epithelial irritation and secondary vascular damage resultant from nicotine. The author concurs in the current concept of the actual increase in bronchial carcinoma.

The ratio of involvement of sexes was 6.75 to 1 in favor of males, and the greatest percentage occurred from 50 to 70 in the male, and from 45 to 55 in the female. The occupation of the patient is important and the high incidence noted in painters is attributable to chronic lead poisoning and vascular damage rather than bronchial irritation. A unique explanation for the increased percentage in waiters is their possible continuous exposure to tobacco smoke. Curiously in discussing the etiology in persons of healthy outdoor occupations, the possibility of frequent colds or pulmonary affections in this type of work is considered as predisposing. The site of involvement showed upper lobe origin two and one-half times as often as lower lobe and definitely a predilection for the right side.

WILLIAM R. STECHER, M D

CANCER (THERAPY)

CANCER (DIAGNOSIS)

Is There Any Practical Worth of the Klein Reaction

Vitamins in Cancer Therapy T. Gordonoff and F. Ludwig Schweiz med Wehnschr Nov 14 1936 46, 1129 1130

There is no foundation for the thought that vita-

(Terminal Ileitis) M Friedl-Meyer Schweiz med Wchnschr, May 23, 1936, 66, 508-512

A cursory review of the literature upon this subject is excellently presented. The lesion involves the ileocecal valve and usually 10 to 30 cm of the contiguous distal ileum, but rarely is there extension into the cecum proper. Pathologically, the condition is a chronic enteritis with phlegmonous extension and marked proliferative reaction of the bowel walls, causing marked thickening and ensuing stenosis comparable to a rigid rubber hose. Clinically this is manifest in symptoms of partial intestinal obstruction, as a rather late finding with palpable tumor formation. The early stages of inflammation are evidenced as rather strong simulation of an entero-colitis, with foul smelling stools with pus, blood, and mucous membrane casts, or subacute appendicitis. Perforation of the involved wall leads to fistulae between bowel and cecum or sigmoid colon, or a walled off abscess, with late abdominal penetration and resulting fecal fistula. It should be borne in mind that anemia and inordinate loss of weight are cardinal features and may suggest tuberculosis or malignancy.

Roentgenologically, the diagnosis is not difficult if borne in mind, for a barium meal shows delayed ileal transit with narrowing of the terminal ileum as manifest by the pathognomonic cord or ribbon sign. If partial small intestinal obstruction exists, dilated small intestinal loops are readily noted. The cecum presents a filling defect due to the enormously thickened Bauhin valve. Opaque enema examination confirms cecal defect and absence of further colonic involvement plus ileo-cecal incompetency, which phenomenon is exceedingly valuable in outlining a stenosed terminal ileum. Both internal and external fistulae can be shown if present.

A differential diagnosis must be made of lymphopathia venereum (Frei test), tuberculosis, actinomycosis (cutaneous reaction), carcinoma, and bacillary or amebic dysentery. As to etiology in over half the cases reported there had been a prior appendectomy, and rarely was there an active appendicitis present. There is the possibility of chronic lymphangitis of the regional mesentery causing elephantiasis of the involved gut, with superimposed secondary infection. The fact that there is such a marked anemia and anacidity suggests that these are primary factors with production of an enterogenous infection due to low resistance. Enterococci have been noted in stool but their significance is unknown. In no cases was there evidence of lymphopathia venereum.

Treatment consists of resection of the affected part if the patient is in physical condition to undergo an operation and secondary enterocolonic anastomosis.

WILLIAM R. STECHER, M.D.

The Roentgen Examination as an Aid for Indication for Pylorotomy in Infants. G. Paschla. München. med Wchnschr. Dec 4, 1936 49, 2007, 2008.

In 1930 a review of the literature from 1842 disclosed the astounding fact that there was an 18 per cent

mortality in the treatment of pylorospasm in infants. In regard to the results of the Weber-Ramstedt operation for pyloric stenosis, the death rate was 25 per cent. However, this rather poor showing was not entirely resultant of the operation *per se*, but mainly due to the malnourished infant, who had been allowed to undergo marked wasting before operative intervention was instituted. It follows that betterment of statistics can be accomplished only by earlier surgical intervention in cases in which it is indicated, to be done only when a definite diagnosis is made. Unfortunately, the current practice appears to be relegation of cases to the surgeon only when marked and irremediable symptoms are present, *viz.*, marked vomiting, inordinate weight loss, etc. It is the practice of some physicians to procrastinate a definite interval of time three days to two weeks, before seeking surgical help. This study was made to promulgate such certain definite indications for pylorotomy as could be accomplished by x ray examination.

The accepted criterion for surgical intervention to date has been the presence of marked three hour gastric retention. The author presents his own conclusions based upon experimental and clinical data. The roentgenologic technic of examination briefly is as follows: stomach is emptied in morning, two teaspoonfuls of barium is given, and infant is immediately roentgenoscoped to determine tonus, peristalsis, and emptying mechanism of stomach. At four and eight hours, respectively, control roentgenograms are obtained.

The author's deductions follow: 1. If there is four- and eight-hour complete retention in the stomach, an immediate operation is mandatory. 2. If at four hours there is less than one-fourth of the initial meal retained, or at eight hours less than one-half, an immediate operation is indicated. 3. If the gastric emptying function is good in the first four hours (more than one-fourth of contrast medium in intestines) and in the second four hours definite delay or absence of further emptying of stomach, then gastric atony is to be anticipated, which is a serious complication of pylorospasm, and the best procedure is immediate operative intervention. 4. If there is ejection of more than one-fourth of the contrast meal in the first four hours and one-half by eight hours, then there is a good prognosis for conservative medical management. If there be any doubt as to the degree of gastric retention, it is advised that operation be instituted. By following the above criteria the mortality in the author's series was reduced from 2 to 3.5 per cent. 5. In the case of Group 4, if with conservative handling the goal has not been reached in from 10 to 14 days, then operation is advised. If there be concurrent cardiospasm that in itself is no contra-indication for pylorotomy, for this phenomenon has been observed to disappear immediately after pylorotomy. Also, gastric atony with concomitant gastritis is no contra-indication to surgery.

It is understood that certain clinical types of far advanced toxic constitution are extremely bad risks

March Foot Joseph F Elward Am Jour Roentgenol and Rad Ther, August, 1936, 36, 188-193

The author reviews the literature on the subject and also the various theories of causation and reports two additional cases, one which he classifies as of the acute type and designates "pied forcé," and the other of the chronic type properly called "pied surchargé." Differential diagnosis from sarcoma, Köhler's disease, and other pathologic and traumatic conditions is discussed

J C HABBE M D

FOREIGN BODIES

Broken Needle in Pericardial Sac of a One and One-half year-old Child Hansen and Gruninger Münchener med Wchnschr, Sept 11, 1936, 37, 1513, 1514.

A case is discussed which presented symptoms of mediastinal pressure, with generalized edema, dyspnea, ascites, hepatic and splenic enlargement and marked albuminuria, due to a hemorrhagic exudative pericarditis, secondary to puncture by a broken needle. This was only suspicioned after roentgenographic examination. The site of entry was undetermined, but theoretically it was considered to be trans-dermal rather than per oral. The needle was successfully removed under roentgenoscopic control

WILLIAM R STECHER, M D

GALL BLADDER (NORMAL AND PATHOLOGIC)

Primary Carcinoma of the Gall Bladder E Savarese Arch Ital di Chir, May, 1936, 43, 297-313 (Reprinted by permission from British Med Jour, Sept 12, 1936, p 40 of Epitome of Current Medical Literature)

The author, who records illustrative cases in women aged from 32 to 60, maintains that primary carcinoma of the gall bladder is not so rare as is generally supposed. The condition is more frequent in women than in men in the proportion of 5 to 1. The average age at which it occurs is from 57 to 60, but cases have been recorded in young adults and even in childhood. All writers are agreed as to a close connection between a chronic inflammatory process and carcinoma of the gall bladder: the incidence of cholelithiasis ranging from 73 to 95 per cent in their cases. Macroscopically the tumor may assume a villous, an infiltrating, or a gelatinous form. Although it may be found in every part of the gall bladder, the site of election is the fundus. The tumor may invade the colon, stomach, duodenum or liver. Histologically primary carcinoma of the gall bladder may be a cylindrical epithelioma or a diffuse carcinoma. The onset is insidious. Three stages may be distinguished, the first being characterized by pain and dyspepsia, the second by the appearance of the tumor and mechanical disturbances due to pressure caused by it and the third by diffusion of the newgrowth. Jaundice is not a constant or early symptom but is

found in about 60 per cent of recorded cases. Early diagnosis is impossible. As a rule, the condition is discovered only at operation. Kirklin has reported 20 cases in which the tumor was discovered by radiographic examination, in four of which the diagnosis was confirmed by operation. The prognosis is always unfavorable. The duration of the disease varies from a year to a few months. Death usually occurs within six months of the appearance of jaundice. Treatment consists in removal of the gall bladder and the adjacent glands. The operation is attended with a heavy mortality (50 per cent), and there is little chance of a final recovery, death usually taking place within from one to five years.

Cholecystography E L Jenkinson. Jour Am Med Assn, Sept. 5, 1936 107, 755-757

Cholecystographic examinations were made on 95 individual patients. Of these 70 showed normal visualization. All the 95 patients had symptoms thought to be due to gall bladder disease. Three patients failed to retain the dye for fifteen minutes and the lack of filling was not considered sufficient evidence to warrant a diagnosis of non function. These patients refused further examination. All patients with non filling gall bladders were examined again after a period of one month.

Fifty were to be placed on a normal diet as controls and 50 on a gall bladder diet, rich in fats, with the addition of dehydrocholic acid three and three-quarters grains (0.25 gm) three times a day with meals, when 100 non-filling gall bladders were obtained.

A patient with fairly typical gall bladder syndrome following one negative gall bladder response does not conclude the necessity for immediate operative intervention, as the patient will frequently show a normal cholecystographic response at a later examination.

The clinical course of many of these patients paralleled quite accurately the cholecystographic response, that is taking a patient with symptoms attributed to gall bladder disease, followed by a negative cholecystographic response, there was usually a marked improvement of the symptoms following medical management including dehydrocholic acid. Likewise the cholecystographic response at this time was either improved or normal. These same patients who frequently showed an exacerbation of symptoms and were immediately subjected to cholecystographic examination usually showed a poorly functioning or a non functioning gall bladder. A few patients showed no improvement after a rather prolonged medical regimen and likewise showed no improvement in the radiographic gall bladder appearance.

CHARLES G SUTHERLAND M B (Tor)

GASTRO-INTESTINAL TRACT (DIAGNOSIS)

Casuistic Contribution Regarding Tumor like Ulcerative Stenosing Inflammation of the Distal Ileum

(Terminal Ileitis) M Friedl-Meyer Schweiz med Wchnschr, May 23, 1936, 66, 508-512

A cursory review of the literature upon this subject is excellently presented. The lesion involves the ileocecal valve and usually 10 to 30 cm of the contiguous distal ileum, but rarely is there extension into the cecum proper. Pathologically, the condition is a chronic enteritis with phlegmonous extension and marked proliferative reaction of the bowel walls, causing marked thickening and ensuing stenosis, comparable to a rigid rubber hose. Clinically this is manifest in symptoms of partial intestinal obstruction, as a rather late finding with palpable tumor formation. The early stages of inflammation are evidenced as rather strong simulation of an entero-colitis, with foul smelling stools with pus, blood, and mucous membrane casts, or subacute appendicitis. Perforation of the involved wall leads to fistulae between bowel and cecum or sigmoid colon, or a walled-off abscess, with late abdominal penetration and resulting fecal fistula. It should be borne in mind that anemia and inordinate loss of weight are cardinal features and may suggest tuberculosis or malignancy.

Roentgenologically, the diagnosis is not difficult if borne in mind for a barium meal shows delayed ileal transit with narrowing of the terminal ileum as manifest by the pathognomonic 'cord or ribbon sign'. If partial small intestinal obstruction exists, dilated small intestinal loops are readily noted. The cecum presents a filling defect due to the enormously thickened Bauhin valve. Opaque enema examination confirms cecal defect and absence of further colonic involvement plus ileo-cecal incompetency, which phenomenon is exceedingly valuable in outlining a stenosed terminal ileum. Both internal and external fistulae can be shown, if present.

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WILLIAM R. STECHER M.D.

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The Roentgen Examination as an Aid for Indication for Pylorotomy in Infants G Paschla München. med Wchnschr, Dec 4, 1936, 49, 2007, 2008

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for operation, and measures to bring the patient into condition in which there may be hope of surviving the ordeal of operation are to be employed. Succinctly surgery should not be considered as the last resort but as an early procedure when indicated.

WILLIAM R. STECHER, M D

GASTROSCOPY

Diagnosis of Diseases of the Stomach by Gastroscopic and X ray Relief Studies J Schloss, A Ettinger, and J H Pratt Am Jour Med Sci, February, 1937, 193, 171-180

In the light of the great strides in the development and use of the gastroscopic and roentgenologic methods for the diagnosis and treatment of gastric diseases, the authors were prompted to report their observations on 100 cases in which both methods of study were employed. They briefly review the development of the gastroscope and x ray methods of gastric study.

The greater efficiency of modern x ray visualization of the stomach is due to the application of four principles: (1) The use of a small amount of opaque medium in order to maintain some degree of transparency, (2) the application of graded compression in order to fill the depressions between the prominent structures of the mucous membrane, (3) fluoroscopy of the patient in various positions demonstrating the contours of the stomach in different planes, (4) small films snapped in selected positions during fluoroscopy, enabling the examiner to obtain permanent records of fleeting observations.

"Gastroscopy may be defined as the intravital inspection of the stomach mucosa by a non-operative procedure." The Wolf-Schindler gastroscope as used to day, consists of a semi rigid upper portion and a semi-rigid lower portion, the latter portion containing a system of lenses of short focal distances. Its main advantage is that it demands less training than the use of the rigid type. Its greatest disadvantage is its 90° optic which requires that it be passed blindly through the esophagus, thus increasing the danger from perforation of the esophagus of cardia in cases in which an unexpected obstruction may exist. X ray studies on esophagoscopy should precede the passage of the gastroscope in cases in which there is a possibility of such lesions.

The authors briefly describe the method of using the gastroscope.

The principles of both methods are summarized by stating that "we may say that the x-ray examination is a study of an elaborate plastic cast of the entire organ, gastroscopy gives an immediate natural picture of circumscribed areas of the interior surface of the stomach which can be pieced together like a mosaic pattern."

The roentgenologic examinations inform us about shape, size, contour, tone motility peristalsis position emptying time, and gastric secretion of the stomach. They may reveal large and medium sized depths of

the wall" and also reveal "comparatively coarse changes of the mucosa itself and of the mucosal folds."

Gastroscopy on the other hand, may demonstrate even very fine changes and defects of the surface, it shows the folds in their natural appearance. It demonstrates the color of the mucous membrane, the distribution of blood, the filling of the blood vessels, hemorrhage, and so on. It may also give some impression as to tone, peristalsis, and gastric secretion. X ray examination is superior where localized lesions, especially if not too small are present, whereas generalized pathologic processes and very fine superficial changes are more the domain of the gastroscope. Therefore, the two methods are in no way in competition, but supplement each other successfully. The very lesions which x ray examination fails to reveal can usually be visualized with the gastroscope, while those which can scarcely be seen by gastroscopy seldom cause difficulties for the roentgenologist."

The authors review and discuss their experiences with both methods in studying 100 consecutive cases in which both methods were used. From this study they concluded that, For the diagnosis of gastritis, gastroscopy is by far superior to x ray relief technic. Erosions and atrophy of the stomach mucosa can be diagnosed for all practical purposes by gastroscopy only.

Gastric ulcers are more frequently encountered in gastroscopy than in x ray. In cases of duodenal ulcers almost always accompanying changes in the stomach are present.

For the diagnosis of stomach tumors and of post operative changes x ray relief method and gastroscopy supplement one another in an almost ideal way."

G E BURCH, M D

GYNECOLOGY AND OBSTETRICS

Osteomalacia L Fränkel Schweiz med. Wchnschr Nov 14, 1936, 46, 1121, 1122

The author discusses the various theories and types of osteomalacia, and is convinced of the endocrine relationship of inter-osteomalacia and ovario-priva (antagonists). The possibility of a pluriglandular effect rather than primary ovarian dysfunction etiology is to be considered, but nonetheless there is empirical proof of the improvement of osteomalacia with the institution of castration, either surgical or radiologic. However, such radical procedures are not necessary since the desired result can be accomplished with anti ovarian hormone together with dietary régime and vitamin D and sunlight.

WILLIAM R. STECHER M D

HEART AND VASCULAR SYSTEM

Pericardial Calcification Karl Herman München med Wchnschr May 29 1936, 83, 889-892

This is not a rare or difficult diagnosis and, combining clinical and roentgenologic studies make it possible

in all cases. Clinically, one can summate the main findings as long history of affection, pulse clear but distant, with absence of murmurs, and Wenckebach's sign of highest pulse after expiratory pause. It usually occurs in individuals of middle age. Characteristic of the condition are systolic retraction and diastolic heave of the anterior chest, with lagging of the lower portion of the sternum on deep inspiration. Of greatest importance is the disparity between functional and morphologic signs. Passive pulmonary congestion, with right heart failure, marked cervical venous congestion and pulsation, which is exceptionally marked in the recumbent posture, are almost always present. Hepatic enlargement and ascites are common.

Roentgenologically, the heart presents calcification along its border (most often along the left side), which can be observed roentgenoscopically on occasion. Heart excursions and motion on respiration are very limited, with cardiac apex fixed, even upon change of body position to the lateral recumbent posture. Frequently pericardio-pleural synechiae, causing tenting of the diaphragmatic dome, are observed. Diaphragmatic excursions are restricted along the mesial aspect, with elevation of the right cupola due to hepatic congestion. In inspiration heart and cupola (cardiophrenic angle) does not diverge or widen. The retrocardiac space is slightly encroached upon due to right heart failure. An important study is a grid diaphragm roentgenogram localized to the heart which may well portray the calcification or add information relevant to other intra- or extra-cardiac calcification. Differential diagnosis must be made of valvular or coronary calcification, aortic calcification, calcified echinococcal cysts, bronchial cyst or other rare calcified tumors. Kymography lends valuable aid to localization and extent of concretion-pericardium enabling effective surgical removal.

WILLIAM R. STECHER, M.D.

Thus between every 11 mm of exposed film there is 1 mm of white unexposed film, which divides the kymogram into frames. This method records simultaneously the movements of multiple points on the border of the heart or other structure roentgenographed. The points recorded are those small areas on the heart border which overlies a slit in the grid.

The size and shape of the heart are studied in the same manner as in the usual roentgenogram. The trough of a wave is that particular point at maximum systole, and the peak of the wave is the same point at maximum diastole. The lower leg of the wave is a record of the diastolic phase of the cardiac cycle, and the upper leg is a record of the systolic phase. The speed and amplitude of a movement alter the contour of the resulting waves, and these factors must be appreciated when analyzing kymograms. The time occurrence of movements in the different cardiac chambers and great vessels is determined by tracing side by side the waves in the various frames on a sheet of ruled paper. Each tracing is begun at the white line at the bottom of the frames. The time relationship of the movements is then established by drawing parallel lines, and all points on the same parallel line occur at the same instant.

Diagnostic kymographic tracings occur in aortic regurgitation, aortic stenosis, syphilitic aortitis, hyperthyroidism, myxedema, constrictive adhesive pericarditis, tuberculous pericarditis, pleuropericardial-diaphragmatic adhesions, aneurysms of the ascending aorta, cardiac infarction, "irritable" heart, and a few arrhythmias. These tracings also supply information concerning the tonicity of the heart muscle that is of prognostic importance. The authors were unable to recognize any consistent changes in the kymograms of patients with hypertension and arteriosclerotic heart disease.

CHARLES G. SUTHERLAND, M.B. (Tor.)

Roentgen Kymography in Diseases of the Heart
A Relatively New and Efficient Aid in Diagnosis
Wendell G. Scott and Sherwood Moore. *Jour. Am. Med. Assn.* Dec. 12, 1936. 107, 1951-1954.

Roentgen kymography is a new and useful method recently developed for graphically recording the physiologic movements of an organ or structure on a single x-ray film. The basic principle was first conceived by the Polish physiologist Sabat, in 1911 and independently by Gott and Rosenthal in 1912. Stumpf of Munich devised the multiple-slit grid and perfected the apparatus mechanically, so that by 1931 the method was practical, inexpensive, and of clinical value. The essential part is the grid, a large sheet of lead in which narrow horizontal slits are cut every 12 mm apart. The opening in each slit is 0.4 mm wide. The patient stands next to the grid and during a continuous exposure of one and one-fourth second, the cassette slowly moves down behind the fixed grid a distance of slightly less than the space between two slits—actually 11 mm.

THE HIP JOINT

Early Treatment of Congenital Dislocation of the Hip Joint. Gerhard Haberler. *München med. Wchnschr.*, June 12, 1936. 83, 967, 968.

The difficulty in treating this entity lies mainly in the difficulty of an early diagnosis which can be accomplished only by roentgenography. The predisposing cause of this condition is shallow acetabular cavity and poor shelving effect, the actual luxation occurring later in life. The author stresses the fact of our meager knowledge of the normal development of the hip joint, which is mandatory in deciding whether or not a suspicious case is luxated. To date, many mistakes have been made by clinician and radiologist, particularly in the degree of luxation estimate, for an improved luxation may remain outside the acetabular cavity or, when actually, good reduction has been accomplished the distortion on the roentgenogram,

with the femur in abduction, may simulate continuance of the luxation. Diagnostic criteria for early diagnosis are enumerated: (1) roentgenographic demonstration of shallow acetabular cavity, with poor shelving, and cephalic and laterad displacement of femoral head, (2) when femoral head can be felt to be replaced clinically, (3) if, in attempting to replace luxation, shortening of adductors occurs, with associated marked resistance.

The author concludes that the earlier the treatment, the better the end results, and the simpler the method of treating, varying from mere abduction with straddle pillows, or splints to plaster cast.

WILLIAM R. STECHER, M.D.

HODGKIN'S DISEASE

Roentgen Treatment of the So-called Malignant Lymphomas. F. W. O'Brien. *Jour Am Med Assn*, Dec. 19, 1936, 107, 2022-2025.

The disease entities discussed are described by their common designations—Hodgkin's disease, chronic lymphatic leukemia, and chronic myelogenous leukemia. Various attempts to classify them on a basis of stem cell or morphologic grounds and the merits of the controversy as to whether one or the other is an infectious process need not detain one. For all essential purposes, they involve radiosensitive tissues and behave like neoplastic processes, terminating almost invariably in death.

Roentgen therapy was used locally in fractional doses in the treatment of 45 cases of Hodgkin's disease, 12 cases of lymphatic leukemia and 29 cases of myelogenous leukemia over a ten year period with symptomatic relief. Some patients enjoyed relatively good health over long periods of time, but there was no convincing evidence of prolongation of life by irradiation.

CHARLES G. SUTHERLAND, M.B. (Tor.)

Hodgkin's Disease and Deep X-ray Therapy. W. L. Watt. *British Med Jour*, Oct. 10, 1936, pp. 712, 713.

Watt states that ordinary x-rays act well in Hodgkin's disease as long as the glands are localized and superficial. Cases so treated respond afterwards to deep radiations just as well as untreated cases. Deep therapy is recommended because the response to treatment is much quicker and by varying the voltage and filterage to suit the glands to be treated, one can in a short time treat masses of glands no matter where situated. The first irradiation should usually cover all affected areas and may be spread over a period from a week to a month as necessary. Any recrudescence should be treated at the earliest possible moment. While deep therapy cannot be considered a cure of the disease yet it unquestionably prolongs life and often restores the patient to a more or less normal active

life in a very short period of time. With regular observation and treatment when necessary, there is on the average a three-to-one hope of living from two to five years and a one-to-three hope of living from five to twelve years, or longer.

W. A. SODEMAN, M.D.

INFLAMMATORY DISEASES

Further Studies Regarding the Heating of Pelvic Organs with Short Wave Therapy. W. Rech and W. Raab. *Strahlentherapie*, 1936, 57, 623.

The authors used wave lengths of 6 and 12 meters in the treatment of pelvic inflammatory disease. The single application lasted 20 minutes. Schliephake's condenser electrodes were applied laterally. In this manner the temperature increase in the small pelvis ranged from 0.3 to 0.7 degree centigrade. The therapeutic results are explained on the basis of an increased circulation and also an increase in the metabolism of the treated tissue. The selective effect of short waves on the cells and the tissue is also considered probable.

ERNST A. POHL, M.D., Ph.D.

THE LARYNX

Radical X-ray Treatment of Malignancy in the Larynx and Pharynx. J. H. Douglas. *Webster British Jour Radiol*, December, 1936, 9, 799-804.

The author discusses the necessary steps in the treatment of malignancy of the larynx and pharynx by the Coutard method of roentgen therapy. The first essential is a complete clinical diagnosis, including site, origin of lesion, and probable extent of invasion. To accomplish this and to obtain the best results throughout the course of treatment, the co-operation of a laryngologist is essential. The second step consists of x-ray examination of the region of the lesion to show the following condition of the cartilages, the soft tissues, the upper esophagus and the cervical vertebrae. The chest should also be studied on the roentgenogram as in some cases early metastases to the lungs may be noted. The third procedure should consist of histological examination and grading according to Broders or some similar scale. Biopsies may be made during the course of treatment rather than before therapy.

The relative value of the radium gram unit and x-ray therapy in the treatment of these cases is still undetermined. While there are definite indications for each form of therapy the irradiated area and the depth dose will be greater with deep x-ray therapy than with the one-gram radium unit.

In employing roentgen therapy each case is thoroughly planned at the beginning of the treatment.

This plan should include the fields to be treated, the daily dose, and the intensity in r per minute. However, in each case the daily dose and the total dose are controlled individually by the general condition and the local reaction

The author reports two cases of malignancy treated by means of the Coutard method in which temporary success has been obtained. Beside these two cases, his series includes 23 cases of cancer of the larynx and pharynx which have been treated by Coutard's method. In 10 of the 25 cases, general or local improvement for varying periods has been noted.

The following suggestions are made by the author: (1) Preliminary gastrostomy in order to rest the affected region as much as possible, (2) irradiation of other fields to include the upper thorax.

J N ANÉ, M D

Further Experiences with the Desensitization of Mucous Membrane during Protracted Fractional Roentgen Therapy. R. Glauner. *Strahlentherapie*, 1936, 57, 670.

In nine cases of carcinoma of the hypopharynx and larynx undergoing roentgen therapy according to the Coutard method the author sprayed adrenalin on the mucous membrane of one side. As shown in a previous communication, this reduced the reaction of the mucous membrane to a minimum. In this new series, three patients showed no reaction at all on the sprayed side, three almost none while two did not finish the series of treatments. One patient showed no effect of the adrenalin. This failure is explained by the fact that the patient was suffering from infection of the mouth and the author uses this case as an example to emphasize the necessity of thorough oral hygiene before starting protracted fractional therapy.

ERNST A. POHLE, M D, Ph D

THE LUNGS

Tomography and its Value in Lung Diagnosis. Kurt Greiner. *München med Wchnschr*, May 29, 1936, 83, 892-895.

Tomography has accomplished the hitherto impossible by visualizing roentgenographically separate body layers at any chosen depth of the body, by blurring out other confusing superimposed shadows. The principle of tomography is essentially a double pendulum arrangement, with tube attached above and film holder below, which revolves about a horizontal axis so that each describes opposite arc directions having a central angle of 45 degrees. The depth of body layer desired is accomplished by adjusting the tomograph to this level. The bronchi and great vessels are well delineated at a desired level while foci and cavities in the lung proper which are not detectable upon an ordinary roentgenogram are easily shown. In the tomogram of the lung disturbing overlying ribs and other densities are eliminated. In pulmonary tuberculosis one can

readily distinguish productive, exudative, and fibrous foci. Of great importance is the determination by this method of the size, shape, character, and relation of cavities to the bronchi. Atelectatic lung regions present characteristic flat regular shadows not observed by the ordinary technic, particularly if located in marginal regions, for, on account of the thinness of the cortical lung-field, an effect of over-exposure causes loss of definition in outline.

A most important use of this method is the detection of cavities entirely obscured by thick curriotic tissue in chronic fibro-ulcerative tuberculosis. Tumorous infiltration and abscess formation can be differentiated. Bronchiectasis is well shown without the aid of a contrast material such as lipiodol. Foreign body localization can be readily performed with this method and one can determine quickly whether a body is extra- or intra-thoracic.

The article is excellently illustrated, and the apparatus is shown, which should convince even the most skeptical of its value. The great progress made in this field offers much in anticipation of further refinements in technic and ultimate diagnosis.

WILLIAM R. STECHER, M D

X-ray Therapy in Carcinoma of the Lung. J. Struthers Fulton. *British Med Jour*, Oct 3, 1936, pp 671-673.

Fulton divides patients presenting themselves for x-ray therapy in carcinoma of the lung into three groups. One group includes those patients with disease so advanced that simpler and more effective palliation may be obtained by morphine. In the second group one finds those patients with loss of weight indicative of metastases or in whom the extent of the lesion is such as to preclude any hope of successful radical treatment. Here palliative irradiation is justified. This is most readily accomplished by a short course of treatment. Dosage should be carried up to the level of a mild erythema at which level quite effective palliation may be obtained. Finally, the third group includes those cases in which radical treatment would appear to be justified. Here debility in the patient is absent and the lesion is of such limited extent that on assessment it will be possible to include it entirely within the irradiation zone.

W A. SODEMAN, M D

The Pseudo-syphilitic Subacute Hilar Bronchopneumonitis of the Undernourished Child. G. Fanconi. *Schweiz med Wchnschr*, Aug 29, 1936, 35, 821-826.

A series of cases presenting confusing roentgenologic, clinical, and sero-diagnostic facts is analyzed, in which (1) roentgenologically, rather typical prominence of the hilar lymph nodes, with prominence of the basal trunk shadows, was compatible with bronchopneumonitis, (2) clinically, an undernourished child was observed intermittently febrile, and suspected of childhood tuberculosis, (3) serologically, all cases presented strongly positive Wassermann reactions.

and negative tests for tuberculosis. When the patients recovered without treatment, the Wassermann reactions became negative. No family history of syphilis was found in any of the cases. This entity must henceforth, be kept in mind, and anti specific treatment not administered in erroneously considered cases of syphilis. The author then considers the incidence of the presence of a positive Wassermann reaction and lung affections, and in reviewing the literature finds it to be a rare combination, nonetheless, other diseases aside from syphilis may give a positive serologic reaction, and the author wishes to add this syndrome which is definitely non tuberculous or syphilitic, as a simulant.

WILLIAM R. STECHER, M D

Athlete's Lung. Tiemann. München med Wchnschr, Sept. 11, 1936, 37, 1517-1520

Histologic proof is presented demonstrating that the lungs in athletes gradually become larger, as do other viscera showing compensatory changes. The size and weight of the lungs increase with the degree of taxation on the organ, but of greatest importance is the increase in number of alveoli.

WILLIAM R. STECHER, M D

PHYSIOTHERAPY

Theoretical Principles of Short Wave Therapy. F. Dessauer. Strahlentherapie, 1936, 57, 582

The author describes briefly the biophysical difference between the action of electrical currents passing through the human body as contrasted with short waves below 30 meters. The possibilities of a specific effect of this wave length range is considered, based on physical laws. The application of the author's etiology theory used in the explanation of the effect of x-rays and radium on cells may also be used in explaining some of the phenomena observed in short wave therapy.

ERNST A. POHLE, M D, Ph D

Short Wave Therapy in Internal Medicine. E. Schliephake. Strahlentherapie, 1936 57, 553

The Present Status of Short Wave Therapy. J. Kowarschik. Strahlentherapie, 1936 57, 593

The Present Status of Short Wave Therapy. C. Urbach. Strahlentherapie 1936 57, 600

Schliephake the well known pioneer in the field of short wave therapy, presents a critical analysis of its present status. While the article does not lend itself to abstracting, it is recommended for study in the original to all interested in this therapeutic agent.

In a very condensed paper Kowarschik discusses the indications and contra indications for the use of short electric waves in medicine. He emphasizes their 'selective' action, i.e. the property of heating certain tissues greatly others hardly and independent of the ohm's resistance.

Urbach names the diseases in which ultra short electric waves have proved of value. He has seen good results in furuncles and carbuncles, sinusitis, empyema of the pleura, lung abscess, pneumonia, periostitis, various types of arthritis, and many others. The apparatus used in his clinic is briefly described.

ERNST A. POHLE, M D, Ph D

Fundamental Principles and Therapeutic Results of Therapy with 'Athermic' Short Waves. P. Liebesny. Strahlentherapie 1936, 57, 615

The author points out that the use of short waves is not without danger, some of their biologic effects being in contrast to the effect of heat alone. The application of 'athermic' short waves, i.e., waves which do not produce any appreciable amount of heat on the skin surface may have excellent therapeutic effect on inflammatory foci either on the body surface or below.

ERNST A. POHLE, M D, Ph D

THE PITUITARY BODY

Pituitary Basophilism (Cushing's Syndrome). Report of a Verified Case with a Discussion of the Differential Diagnosis and Treatment. R. H. Freyberg, Paul S. Barker, L. H. Newburgh, and Frederick A. Coller. Arch Int Med, August 1936 58, 187-212

A verified case of pituitary basophilism showing the classical syndrome has been reported. Nine verified cases of pituitary basophilism showing the classical syndrome are reviewed by the authors. This review includes cases reported since Cushing's review of the literature in 1933. The authors also reviewed 14 cases of cortical adrenal lesions or neoplasms of the thymus gland showing many or all of the characteristics of pituitary basophilism.

The methods of administration of roentgen therapy and results obtained in 18 cases of pituitary basophilism are outlined. The factors of roentgen radiation employed by the different authors were as follows: kv 185-200 ma. 5-30, filter 0.5-0.75 mm Cu plus 1 mm Al, F S D 40-50 time 3.3-240 minutes, number of ports 2-4, number of days treatment occupied 3-49, total r 760-3800. Cushing's case was treated in the following manner: 185 kv, 0.5 mm Cu plus 1 mm Al filter 40-46 F S D, 2 minute exposure treatment occupied six days, total r 1000. One and one half months later the series was repeated. Two months later 1200 r were given in four days. Similar series were then repeated at intervals of three, four, eight, two and two months respectively. Kepler repeated his series of treatments in one month, Wright in two months, and Lawrence in three months.

Wright's case is the only one in which the diagnosis of basophilism having been verified the condition was reported as improved after roentgen therapy. The improvement in this patient was chiefly in the state of

general well-being The blood pressure was higher after treatment than before

In seven of the unverified cases the results were questionable and in eleven the condition was reported as improved In Jamin's case and in Cushing's case the results were very gratifying

The variation in results may be due to the variation in radiosensitivity of the tumor, the age of the patient, duration of illness before radiation, and the method of radiation In every case given a large dose (3,000 r at least), the patient improved The authors believe that roentgen therapy should be intensively and persistently pursued

It is difficult to differentiate between a pituitary and an adrenal involvement Roentgenograms of the sella turcica are of no aid The adrenal gland only occasionally presents signs such as palpable tumor or distorted pyelograms It seems wise in cases in which the causative lesion cannot be definitely determined to treat the patient for pituitary basophilism If no benefit results, the adrenals should be explored The patients having pituitary basophilism are poor surgical risks, and consequently, the exploration of the adrenals should be attempted last

E M SHEBESTA, M D

Basophilic Hyperpituitarism J F Bromley
British Jour Radiol, December, 1936 9, 818-823

The author reports a series of seven cases of basophilic hyperpituitarism which showed improvement and some relief after roentgen therapy to the pituitary The constant factors employed were 200 kv constant tension 1.5 mm copper plus 0.5 mm aluminum filter, and 40 cm anti cathode skin distance All doses were measured with back scatter and calculated on to the pituitary For the first series of treatments, the author employed from 1,500 to 2,200 r The second series of treatments when necessary, were somewhat smaller

Basophilic hyperpituitarism may be recognized as a very definite syndrome associated with involvement of the basophilic cells of the anterior lobe of the pituitary As a general rule the patients are rather young adults Sexual dystrophy in the form of amenorrhea in the female and impotence in the male, is a relatively early feature Hypertrichosis in females and adolescent males and the reverse in adult males are noted Adiposity associated with a dry and coarse appearance of the skin, and the presence of dark striae on the abdomen are other features of this condition Other symptoms are excessive thirst, polyuria aching pains in the eyes, thinning of the hair of the scalp and lumbar backache An atrophy of bone especially of the spine and cranial vault, are observed on roentgenograms However roentgenograms of the sella turcica show no enlargement Increase in blood pressure is common Hyperglycemia and glycosuria may occur Mental depression and mental lassitude are also observed in some of these cases.

J N ANÉ, M D

PNEUMOTHORAX

Therapeutic Artificial Pneumothorax in True Pneumonia L Polak Daniels Schweiz med Wchnschr, Dec 12 1936, 50, 1260, 1261

A brief survey of the literature of this procedure is analyzed and the author makes the following deductions from his own experience, and as shown roentgenologically There is nothing to date to show that the hepaticized lung is or can be collapsed by the pressure of the average pneumothorax As to shortening the period of illness by producing an early crisis, this is questionable The theory that rest of the involved lung will aid by reducing the number of bacteria and toxic products systemically has never been proven and is rather dubious The one outstanding indication for the employment of this procedure is that when inordinate pleuritis is a concomitant of pneumonia, the pneumothorax aids by separating the apposing pleural surfaces Possible complications of this method are mentioned, viz herniation of the mediastinum, only avoided by roentgenologic check, also, sudden cardiac failure, and if bilateral extension occurs, lack of aeration space of the originally collapsed side

WILLIAM R. STECHER, M D

THE PROSTATE

Etiology of Prostatic Hypertrophy W Koch
München med Wchnschr, Sept 11, 1936, 37, 1501, 1502

Prostatic hypertrophy can be artificially induced in dogs by the injection of prolan Inasmuch as Prolan A is found in the urine of human males, presenting hypertrophy of the prostate, the inference is drawn that the etiologic factor well may be hyperfunction of the anterior lobe of the hypophysis It is intimated that proper therapeutics must accordingly be directed additionally to the pituitary dysfunction, and parenthetically whether in the nature of hormonal therapy or radiation

WILLIAM R. STECHER, M D

PRURITUS VULVÆ

Roentgen Therapy of Pruritus Vulvæ Walter Wobler
München med Wchnschr July 31, 1936 31, 1275 1276

Stress is placed upon the etiology of the symptom pruritus vulvæ, particularly the frequent association of diabetes with this symptom When no definite factor can be demonstrated the term 'essential pruritus' is applied The itching is often extremely annoying in this condition and may become intolerable Of 30 females treated with radiation, 18 were in the climacteric, and one had been castrated This is a significant association namely ovarian deficiency and

pruritus vulvæ The technic was as follows S T D 70 cm , 0.5 mm Cu, 200 kv , 6 ma , 15 min , 80 per cent E S D or 640 r This was repeated in two weeks, if no amelioration was present, and very resistant cases were again radiated in eight weeks In most cases the effect was almost immediate, but occasionally delayed results occurred, even to the extent of four months Of these patients, eight were completely cured, 15 greatly improved, and seven unaffected, which succinctly is a betterment of three fourths of the cases by radiotherapeusis

WILLIAM R. STECHER, M D

RADIUM

An Investigation of Internal Radon Therapy F D Howitt, E C Pillman Williams, and S Russ British Med Jour, Jan 30 1937, pp 208-213

This investigation was carried out to determine the physiological or biochemical changes induced by comparatively small doses of radon, to assess any possible value of such treatment upon various diseases, and to use larger dosages to find when they become dangerous. It is pointed out that the introduction of radon into the body presents a totally different problem from that of radio-active salts An apparatus is described for the preparation of radon water which was drunk by the patients in doses varying from one thirtieth of a millicurie to four millicuries Various conditions, including gout, chronic rheumatism, and hyperpiesia were treated

In patients receiving the smaller doses no demonstrable change was found in the clinical condition Blood counts were not affected and no injurious results were encountered In those to whom radon was given in larger doses no improvement was noted in the clinical condition except in certain cases of chronic gout. Chemical analyses of the blood were unaffected with the exception of the uric acid readings in the latter group The erythrocyte count showed a tendency to fall when large doses were employed, in certain instances to a serious degree so that such doses are attended by a definite risk and should be administered with great caution

W A SODEMAN M D

Experiences with Radium Therapy of Hemangioma H Aretz Strahlentherapie 1936 57, 682

The author describes his technic in the treatment of hemangioma by radium He uses applicators at contact filtered through 0.2 mm Ag + 1 mm brass and applies from 4 to 8 mg-hr per square centimeter in order to avoid an erythema This dose may be repeated

after one month and then according to the response of the lesion The total dose rarely exceeds from 20 to 30 mg hr per square centimeter and reaches from 60 to 70 mg hr per square centimeter only in very resistant lesions over a two-year period Of 11 cases with nevus flammeus treated, only two responded well. An analysis of these cases leads the author to the conclusion that this type of angioma should not be treated with radium Eighty six cases with cavernous hemangioma were also treated, of which 52 were cured 18 considerably improved, six improved five had unsatisfactory results, while five developed slight degrees of late reactions

ERNST A. POHLE, M D, Ph D

ROENTGEN KYMOGRAPHY

Roentgen Kymographic Examination of the Diaphragm Following Phrenico-exeresis M. A Sisti and F Soricelli Archivio di Radiologia March-April, 1936, 108-113

The authors report a series of 16 cases studied by the method of G Torelli from two to five months after operation. They feel that roentgen kymography is a valuable method of study for it detects a certain number of operative failures or the return of nerve function which cannot be discovered by any other diagnostic procedure

E T LEDDY, M D

THE STOMACH

Etiology of Carcinoma of the Stomach M Hind hede München med Wchnschr, May 22 1936 83, 852-854

The author makes the following statements Man is the only mammal who dies of carcinoma of the stomach Among uncivilized people who exist on a predominate vegetable diet, carcinoma of the gastrointestinal tract is almost unknown Thus in India there is an incidence of 4 per cent as compared to 60 per cent in Denmark of all carcinomas arising from the stomach " Thus he considers due to the over-nourishing diet, for in no country are there so many obese individuals as in Denmark Since a campaign for a vegetable diet has been waged the morbidity has markedly diminished He concludes that irritation from food particularly spoiled meat excessive use of salt and condiments strong beer brandy and tobacco are cardinal factors in producing malignancy of the gastro-intestinal tract

WILLIAM R. STECHER M D

RADIOLOGY

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PULMONARY PNEUMATOCELE (LOCALIZED ALVEOLAR OR LOBULAR ECTASIA)¹

CERTAIN CONSIDERATIONS IN CYSTIC DISEASE OF THE LUNG

By CARLETON B PEIRCE, A B, M S, M D, and PAUL R DIRKSE, A B, M D, *Ann Arbor, Mich*

From the Department of Roentgenology, University of Michigan

THE common lack of information in regard to the antecedent respiratory history of patients with cystic pulmonary disease raises grave doubt of the propriety of the term "congenital" in a roentgenologic diagnosis of cystic disease.

Recent essayists have included a wide variety of pulmonary changes under the classification of "congenital cystic disease," the common feature being round air spaces of varying size and number. Many have accepted the theory of a congenital abnormality as the basic lesion with apparently little doubt. Actual fluid-filled cysts are rare in the reported cases.

Dr Carl V Weller, Director of the Pathology Laboratories of the University of Michigan, has recently stated to the authors, "I can recall no instance in which we have found changes in the lungs of newborn infants or very young children which have led us to make the diagnosis of congenital cystic disease of the lung. Judging by analogy with other organs derived from the primitive alimentary tract, one would expect that a condition properly thus design-

nated would be encountered occasionally."

Subsequent to birth and the origin of respiratory life, any change in the lungs must be critically analyzed in the light of the age of the patient, the degree of initial post-natal inflation of the lungs, the time relationship of the first examination during which roentgenograms give evidence of the existing structural state of the lungs, antecedent minor or major respiratory infections, or intercurrent disease which may have masked a pulmonary disturbance.

Although it may seem more simple to consider a congenital abnormality the foundation of all the changes which have been included recently under the title of "congenital cystic disease," we find it difficult to accept such a relationship of cause and effect.

It is our opinion that the roentgen diagnosis of cystic pulmonary disease should be more properly classified under the following four main titles, only one of which is known to be of congenital origin.

- I True congenital pulmonary cyst or cysts,
- II (a) Chronic interstitial pneumonitis with emphysema,

¹ Read at the Twenty second Annual Meeting of the Radiological Society of North America, Cincinnati, Nov 30-Dec 4 1936

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W A SODEMAN M D

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ERNST A. POHLE, M D , Ph D

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WILLIAM R STECHER M D

tures, is of relatively frequent occurrence—(20 per cent of cases autopsied—McNeil, *et al.*) Rupture of alveolar or bronchial walls with the production of an interstitial emphysema may occur, affording opportunity for air to dissect along the septa during cough, with the formation of subpleural blebs

With the bronchial infection there is an interstitial inflammation, as contrasted with the intra-alveolar infection of the lobar type. Peri-bronchial alveoli become involved. The peripheral alveoli may be affected secondary to the changes in bronchi and bronchioles, or obstructed by the exudate in the latter. The tendency to confluence of involved lobular areas is common, often with acutely emphysematous intervening lobules due to partial obstruction of the proximal bronchus or bronchiole by exudate and inflammation.

There is then, in association with bronchopneumonia, a ready opportunity, depending upon the dominant pathology of the disease, for the development of (a) sacular to cystic bronchiectasis by means of the damage to the bronchial and bronchiolar walls, or (b) focal acute lobular vesicular emphysema which may not be relieved because of incomplete resolution in or repair of the proximal airway, or (c) peripheral bullous (sub-pleural) emphysema by means of the rupture of the bronchial walls which permit an escape of air into the interstices.

These processes would seem a more logical explanation for the origin of multiple cystic pulmonary disease than congenital abnormality with or without superimposed infection.

The following two cases, in which definite roentgenographic evidence is available of previous non-existence of cystic areas in the lungs, demonstrate the development of a cystic bronchiectasis, sometimes alluded to as "open honeycomb lung," following acute respiratory infections.

Case 1 M I C, female, aged 12 years. At the age of 13 months the patient suffered an onset of "hives and asthma," followed by a cough and subsequent expectoration (at times foul). She had whooping cough at the age of two years (1926), measles at the age of six years (1930), "flu" or pneumonia in December, 1932, with empyema in February, 1933. Multiple thoracenteses, followed by cautery drainage in November, 1933. A peanut was extruded from the chest wound in January, 1934. (There was a presumption that it had been aspirated at the onset of illness.)

Roentgenograms during the period from January, 1930, to January, 1934, were reviewed through the courtesy of Dr H C Schlosser, of Elkhart, Ind.

The patient was admitted to the University Hospital, June 24, 1936, with an interval history as follows. No essential change, continued purulent discharge from the chest wound, cough, sputum, septic afternoon temperature.

Pneumonectomy on Oct 7, 1936 (Dr Alexander). Chronic cystic bronchiectasis.

Pathologic Diagnosis—Thickening and adhesions of pleura, excavation 5 cm in diameter, postero-lateral aspect, near lower border of which a pin-point sinus communicates with lung tissue. Lung markedly compressed, with great thickening of bronchial and bronchiolar walls. Lung appears grossly carnified and bronchiectatic, with empty cyst 4 cm in diameter, having tough whitish wall 3 mm in thickness at apex. A pin-point sinus communicates with a bronchiole at the base of the cyst.

Microscopic Findings—"Bronchiectatic cavities without anthracosis. There is also a large abscess cavity lined by young granulation tissue in which there is no anthracotic pigment. I can see no significance in this distribution. The total amount of pigment in the lung is so small that many areas away from the (bronchiectatic) cysts show no anthracosis at all"—*Dr C V Weller*

Post-operative course was uneventful.

Comment—Some importance has been attached to the distribution of pigment in the lung.

A child whose pulmonary disease began at the age of 13 months, and whose lung at the age of four years was known (by

- (b) Chronic bullous emphysema,
- III Cystic bronchiectasis, and
- IV Pulmonary pneumatocele (localized alveolar or lobular ectasia)

I *True congenital pulmonary cysts* are rare among the reported cases. Evidence of the existence of a cystic lesion has been found in very few fetuses, stillborn, or newborn infants. Several of these have had other associated developmental abnormalities, or the cysts have occurred in aberrant lung tissue. A smaller number of uninfected fluid-filled cysts have been reported in individuals who have passed the first days of life. During the last 12 years, one of us (C. B. P.), has seen but one patient (in consultation with Dr. E. W. Rowe, Lincoln, Nebraska) in whom he believed the evidence of a congenital cyst was unquestionable. The comment of our pathologist colleague, covering an extensive autopsy experience, has been quoted above.

With the exception of the case reported by Stewart, Kennedy, and James, and that by Anspach and Wolman, we have not found any report of co-existent air-filled cystic spaces and closed fluid-containing cysts. If multiple cystic disease were commonly congenital in origin, it is improbable that so rarely the cysts universally would have ruptured and become aerated, as seems to be assumed by others.

While admitting the biologic possibility of congenital pulmonary cysts, we wish to direct attention to the fact that the congenital origin of all cystic changes in the post-natal lung has rarely been demonstrated beyond question or doubt.

II (a) *Chronic Interstitial Pneumonitis with Emphysema*—The interstitial inflammatory changes associated with bronchopneumonia, or the progressive fibrosis in certain unresolved lobar pneumonias may induce sufficient contracture to effect an alveolar emphysema becoming cystic in proportions. The accentuated interlobular septa and interstitial scarring outline the dilated emphysematous lobular areas in the roentgenogram. These rarely show evidence of retained secretions or exudate. Such a

process tends to be lobar or unilateral in distribution.

II (b) *Chronic Bullous Emphysema*—The development of a chronic bullous emphysema in the asthmatic, due to expiratory obstruction by bronchospasm, may present a roentgenographic pattern of multiple air-cysts. As the disease continues there will be more or less fibrosis of the interstitial tissues. The involvement is more generalized, and the septa less prominent than in the case of chronic interstitial pneumonitis with emphysema. The flattening and depression of the hemi-diaphragms is often pathognomonic. In these, also, there is seldom retained fluid or exudate in the saccular air spaces.

The history and clinical features should permit further differentiation.

III *Cystic Bronchiectasis*—The large majority of cases reported since Koontz' paper in 1925, resemble this and the following group in roentgenographic appearance and in the cited previous respiratory infections or common contagious diseases of childhood.

Koontz mentioned the greater incidence on the left side of both bronchiectasis and multiple congenital cystic disease. The anatomic foundation for greater difficulty in aeration of the left lung is evident when one considers the normal tortuosity of the left airway. The trachea deviates to the right as it passes the horizontal aortic arc, and the left stem bronchus then extends at a relatively sharp angle beneath the pulmonary artery, its left ramus producing a more circuitous route than on the right. The further angular origin of the bronchus to the lingula of the upper lobe may well contribute to the poor evacuation of secretions or exudate. This structural character would effect the greater opportunity for bronchiectasis and pulmonary cystic disease on the left.

The frequency of lobular or bronchopneumonia in infancy and childhood, as well as the lobular character of aspiration pneumonia is common knowledge. Necrosis of the bronchial or bronchiolar wall, associated with abscesses arising in these struc-

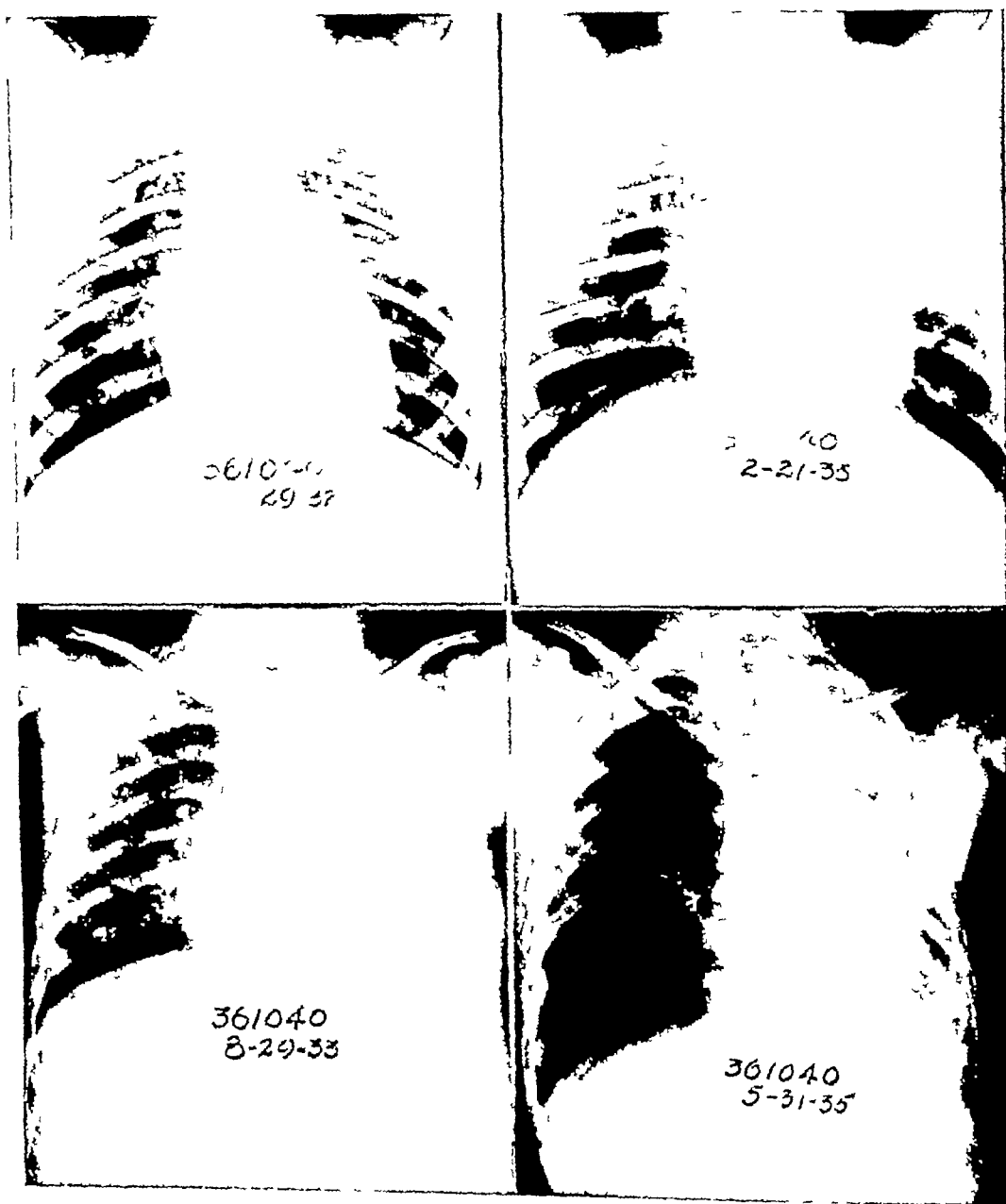


Fig 2 A (upper left) Case 2 Nov 29 1932 Normal chest
 Fig 2 B (upper right) Feb 21, 1933 Gross pulmonary infiltration left upper lung with suggestion of excavation in third inter-space anteriorly
 Fig 2 C (lower left) Aug 29 1933 Post-operative obscuration of left lung, no deflation to permit mediastinal shift thoracotomy ribs three and four in the axilla
 Fig 2 D (lower right) May 31 1935, on admission Cystic bronchiectasis of left upper lobe and lingula, lesser involvement of inferior lobe distortion of left stem bronchus

roentgenogram) to contain a lobular pneumonia (without evidence of cysts), with the subsequent production of further pneumonia and empyema would not have been exposed to appreciable anthracotic dusts

The presence or absence of anthracotic pigments can be valid as evidence of congenital or of acquired disease only when the conditions of life of the individual are considered



Fig 1-A (upper left) Case 1 January, 1930 Inflammatory changes right mesial base No cystic changes evident Normal upper lung A film of February, 1933 (not illustrated) Increased inflammatory changes with accentuation of interlobular septa No cystic areas

Fig 1-B (upper right) June, 1933 Large air-pocket or cyst in right apex (possible encapsulated pneumothorax after thoracentesis) partial consolidation of lower lung, partial deflation with mediastinal shift, multiple air filled round defects in consolidated area

Fig 1-C (lower left) January 1934 (after cautery) Disappearance of large apical area multiple lesser air-filled defects remaining

Fig 1-D (lower right) June 24 1936 Admission bronchogram gross cystic bronchiectasis of the right lung apparent recurrence of an apical pneumatocele partial deflation of lung with mediastinal shift to the right

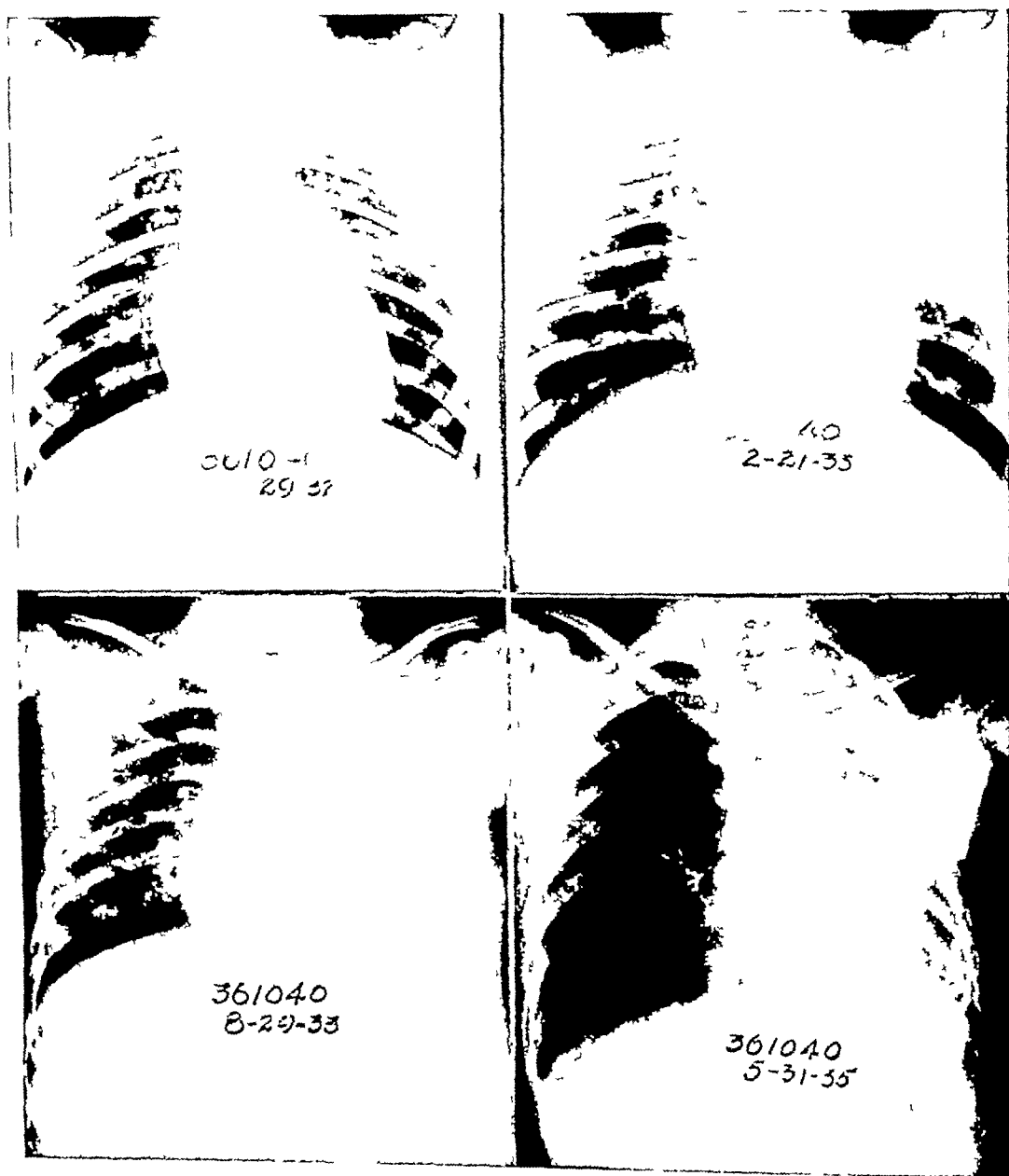


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The presence or absence of anthracotic pigments can be valid as evidence of congenital or of acquired disease only when the conditions of life of the individual are considered

The development of multiple cystic spaces, in the upper lung especially, subsequent to a known normal lung structure in

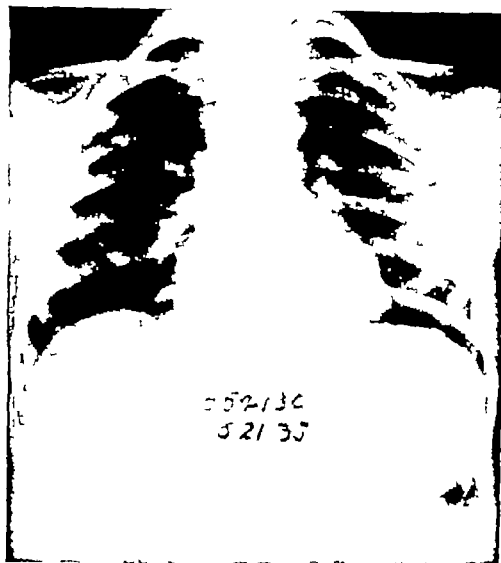


Fig 3 Case 3 March 21, 1935 Normal chest

lung shows remarkably little anthracosis, and that which is present shows no peculiarity of distribution in respect to the bronchiectatic cavities—*Dr C V Weller*

The post-operative course was uneventful

Comment—This cystic bronchiectasis, developing in a child with previously known normal lung structure, presented at the time of admission for definitive treatment a roentgen appearance closely similar to many so-called cases of congenital cystic pulmonary disease

Again the distribution of anthracotic pigment seems to have no significance

IV *Pulmonary Pneumatocele (Localized Alveolar or Lobular Ectasia)*—This fourth group of patients includes those who present a single, or a few contiguous grossly emphysematous alveoli. These ectatic air-spaces tend to increase in volume slowly or rapidly, and may assume massive proportions. Compression of portions of the surrounding lung will be associated

The term "pneumatocele" (*πνευμα* air, *κήλη* tumor) properly denotes the tumorous nature of the air-filled dilated or ectatic alveoli or lobular spaces. Both "alveolar" and "lobular" must be included because of the singular or multilocular character assumed by the emphysematous air-spaces

Our concept of the origin of the pneumatocele is the acute lobular emphysema associated with lobular pneumonia as described above. A persistent check-valve obstruction of the bronchial lumen we believe to be due to either non-resolution of the initial inflammation of the bronchus or a subsequent distortion by the dilated air-spaces. Several essayists have interpreted these changes as indicating the congenital origin of the lesion

The intrapulmonary character is demonstrable by bronchogram or diagnostic pneumothorax. Symptoms, following resolution of the initial infection, are rarely more than an occasional cough and some dyspnea on exertion. The latter depends considerably on the size of the pneumatocele and consequent pulmonary embarrassment. The marked focal emphysema may

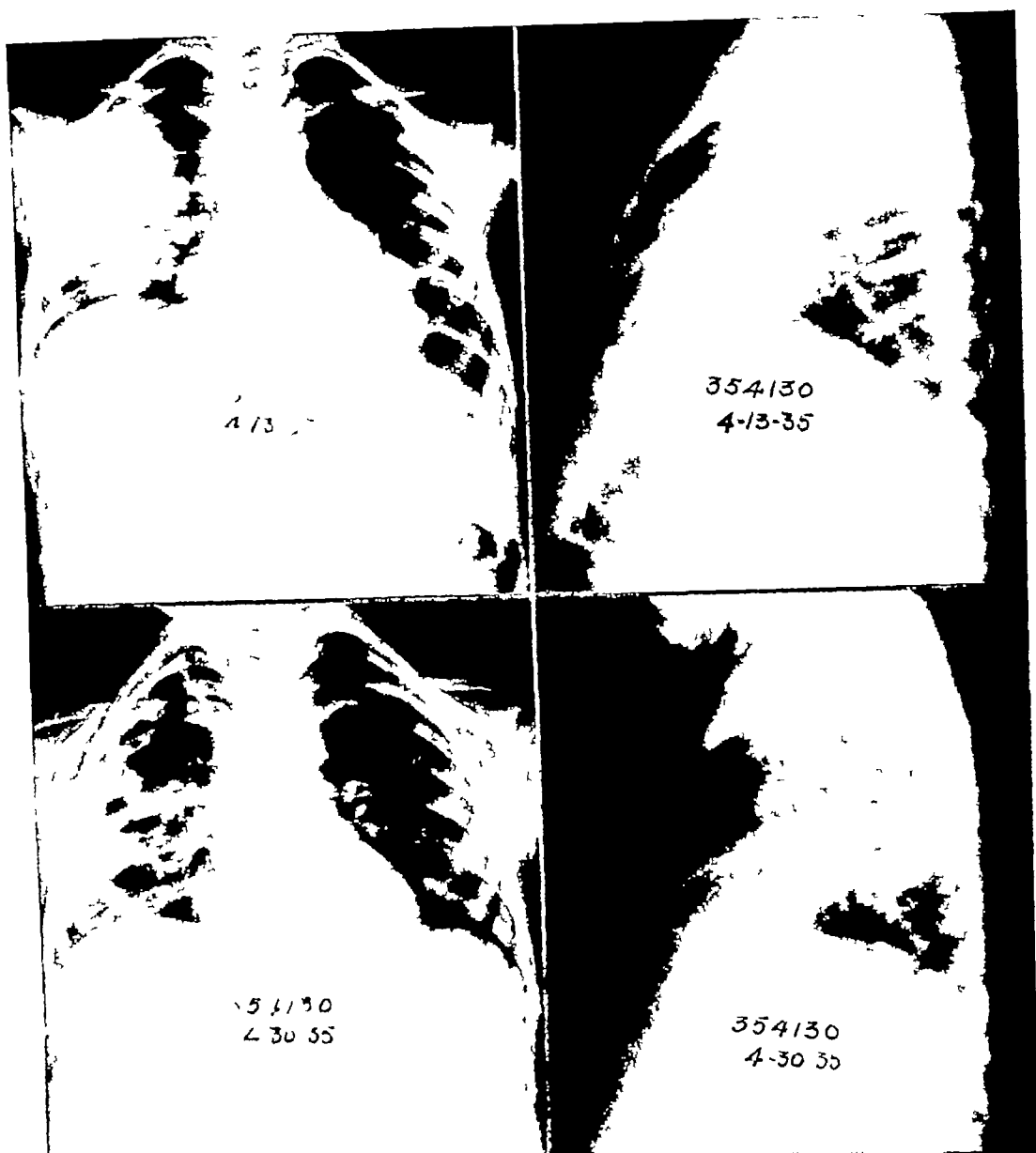
that area, is notable. This is unquestionably an acquired cystic bronchiectasis subsequent to aspiration lobular pneumonia

Case 2 N F, male, aged 8 years. Patient had frequent colds and sore throat. Lung abscess developed at the age of 5, symptoms beginning two weeks after a tonsillectomy in November, 1932. Bronchoscopic drainage followed for eight months. External surgical drainage in July, 1933, with a secondary drainage three months later, subsequent broncho-cutaneous fistula. Recent exacerbation of symptoms with foul sputum and fever, loss of weight.

Roentgenograms made from November, 1932, to August, 1933, were reviewed through the courtesy of Dr J B Flick, and Dr J T Farrell, Jr, of Philadelphia.

Pneumonectomy (left) on June 21, 1935 (Dr Alexander)

Pathologic Diagnosis—Chronic purulent fibroid pneumonia with bronchiectasis and bronchiolar regeneration. No evidence of congenital or developmental changes. This



Figs 4-A and 4-B (upper) Case 3 April 13, 1935 Confluent lobular pneumonia lateral inferior half of right upper lobe

Figs 4-C and 4-D (lower) April 30 1935 Resolution of acute exudative process with appearance of multilocular area of excavation or pneumatic distention mid lateral portion of upper lobe

resolve without evident cause or may progress

The following four cases present examples of this type

Case 3 K S, female, aged 4 years Child has had purulent nasal discharge since whooping cough at the age of 2, with recurrent upper respiratory infection, last in February, 1935, followed by bilateral

otitis media, beginning February 25 A myringotomy was performed on the left side, March 3, bilateral March 8, mastoidectomy on the left, March 13 Patient suffered septic type of fever and pyelitis

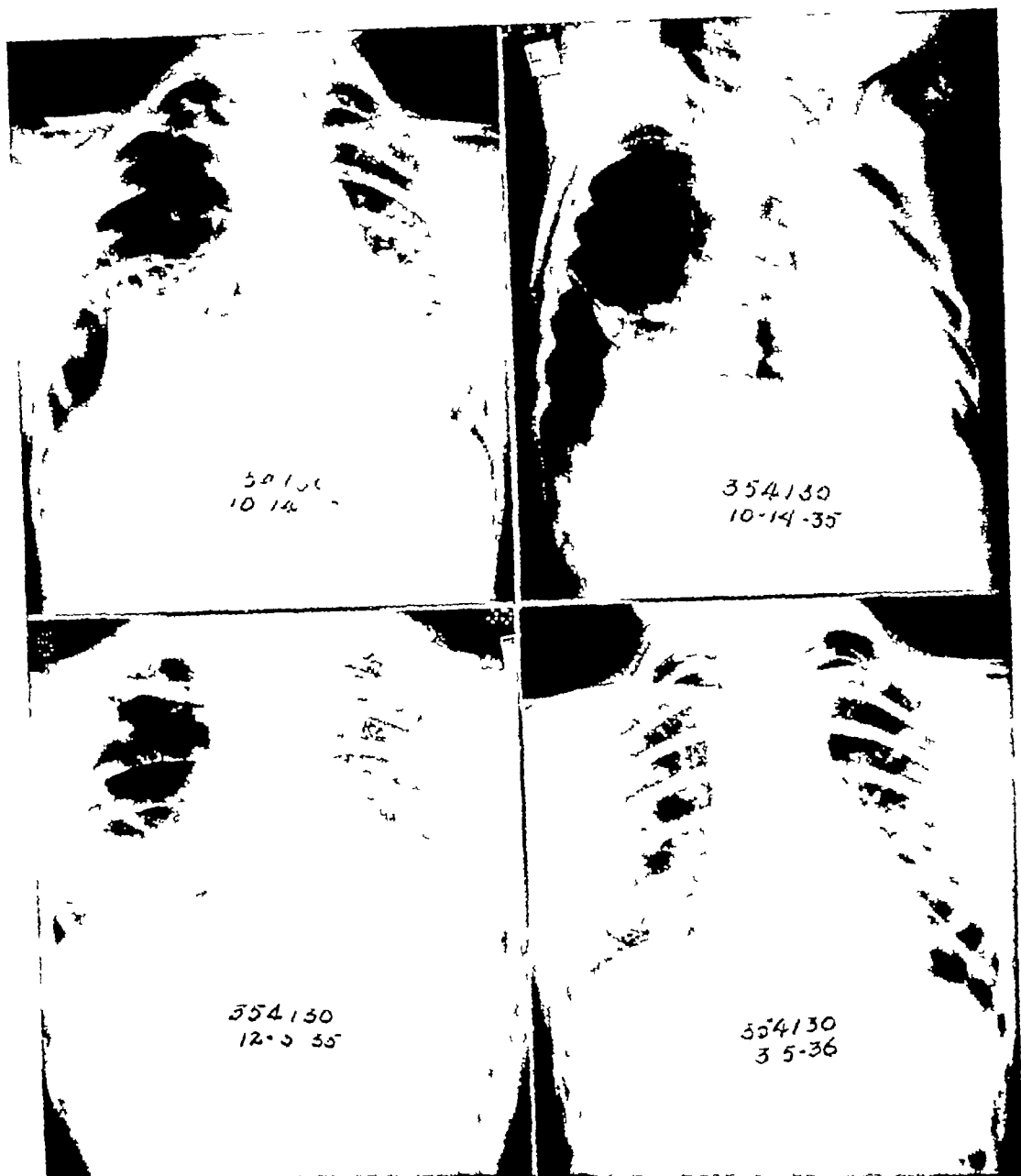
Positive agglutination, *B abortus* and positive skin tests Mild measles, April 5-12 Septic temperature continued slightly higher than before, reaching 106.7° F,



Figs 5-A and 5-B (upper) Case 3 Oct 2 1935 Thin-walled pneumatocele of increased size
 Figs 5-C and 5-D (lower) Bronchogram demonstrated graphically the distortion of the bronchi and surrounding lung Pressure pneumatocele with block of dorsal ramus eparterial bronchus

April 12, cough and restlessness Temperature dropped from 104° F on the 15th to 98.6° F April 16, 1936, not exceeding 102° subsequently, continuously normal after April 24 Sputum was never foul, nor were there any spirochetal organisms Mantoux test was negative

On July 15, 1935, the multilocular area had become a sausage-shaped pneumatocele in the right upper lung, with distortion of surrounding lung and compression of mesial apical lung tissue There was no sputum, but occasional cough, moderate dyspnea



Figs 6-1 and 6 B (upper) Case 3 Oct 14 1935 Induced diagnostic pneumothorax Conclusive demonstration of intrapulmonary character of the pneumatocele, refuting clinical consideration of an encapsulated pneumothorax

Fig 6 C (lower left) Dec 5 1935 Evacuation of iodized oil, persistence of pneumatocele

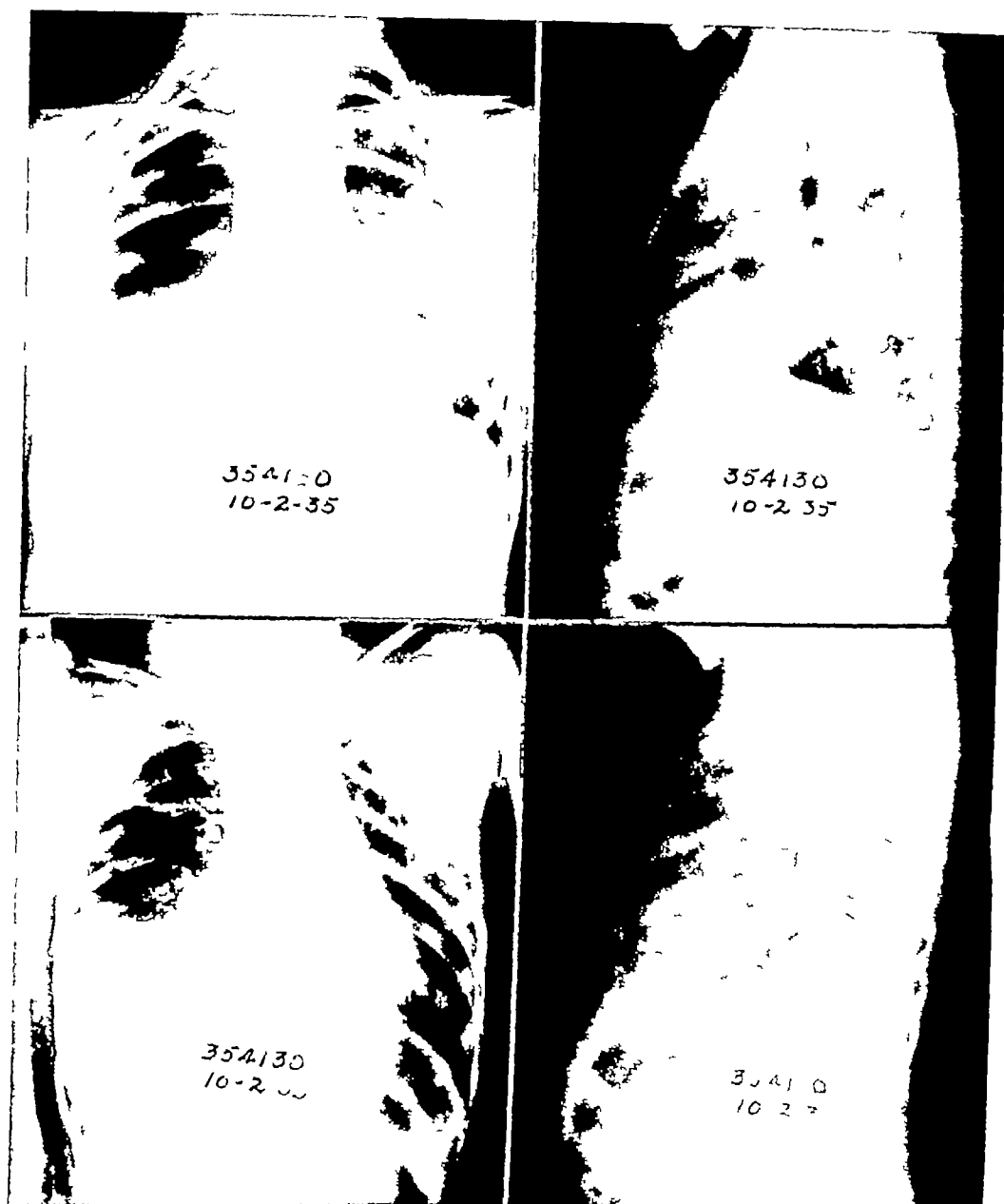
Fig 6-D (lower right) March 5 1936 Minimal irregularity in pattern of bronchovascular markings, right lung disappearance of pneumatocele

In October the child had some dyspnea on exertion but was otherwise well. Occasional dyspnea continued in December.

On March 5, 1936, a routine check-up was made. No change had been noted by parents except increased gain in weight

and disappearance of dyspneic attacks, roentgenographic disappearance of previous pneumatocele.

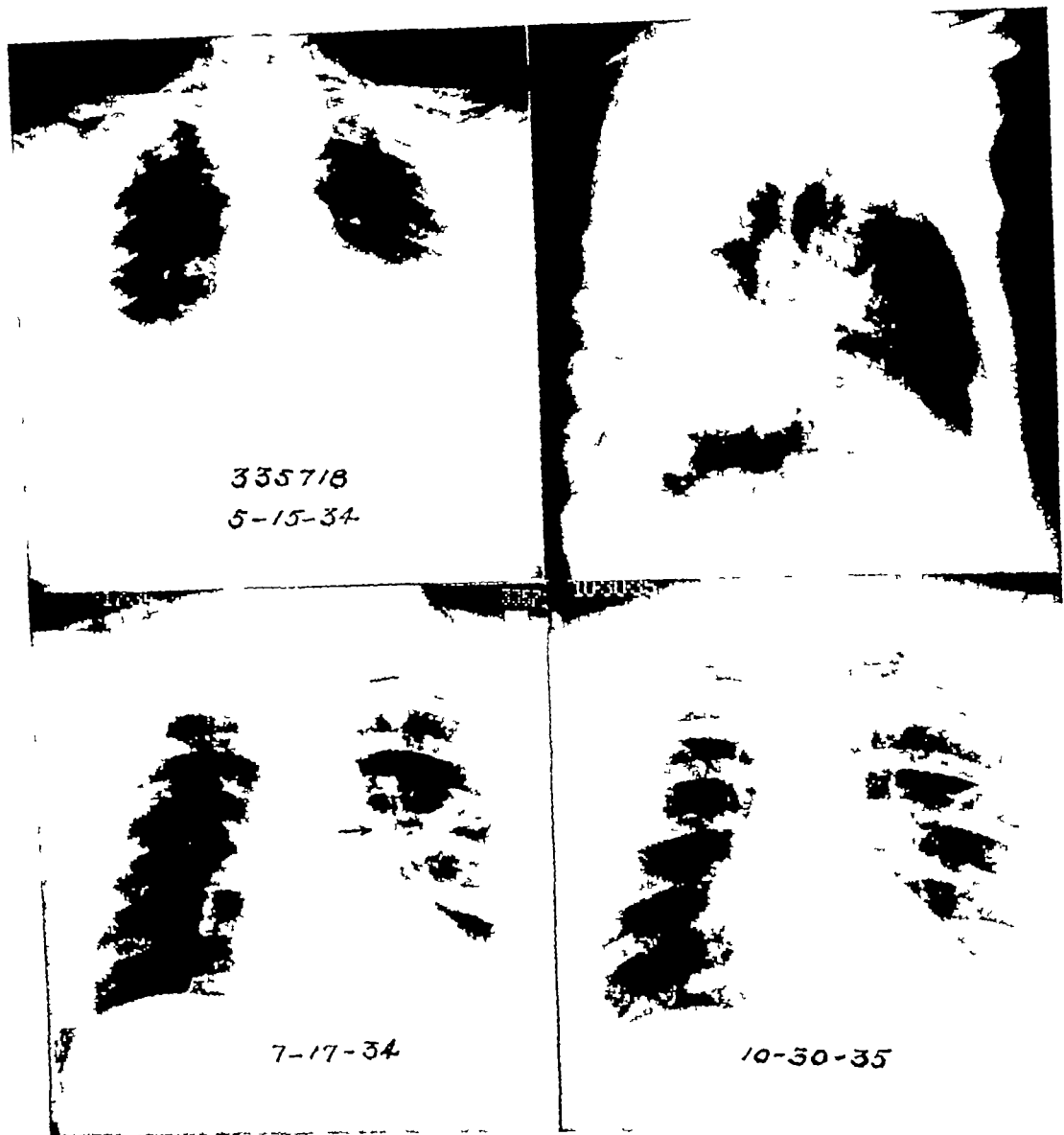
On Sept 17, 1936, routine check-up showed child clinically well, no dyspnea, and essentially normal lung-fields.



Figs 5-A and 5-B (upper) Case 3 Oct 2 1935 Thin-walled pneumatocele of increased size
 Figs 5-C and 5-D (lower) Bronchogram demonstrated graphically the distortion of the bronchi and surrounding lung Pressure pneumatocele, with block of dorsal ramus eparterial bronchus

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Figs 8-1 and 8-B (upper) Case 4 May 15, 1934 on admission Small diffuse pneumonic area in apex of left inferior lobe (area supplied by the dorsal branch of left stem bronchus) best seen in the lateral, no cystic areas

Fig 8-C (lower left) July 17 1934 Regression of exudative lesion with pneumatocele in center, palsy of left diaphragm

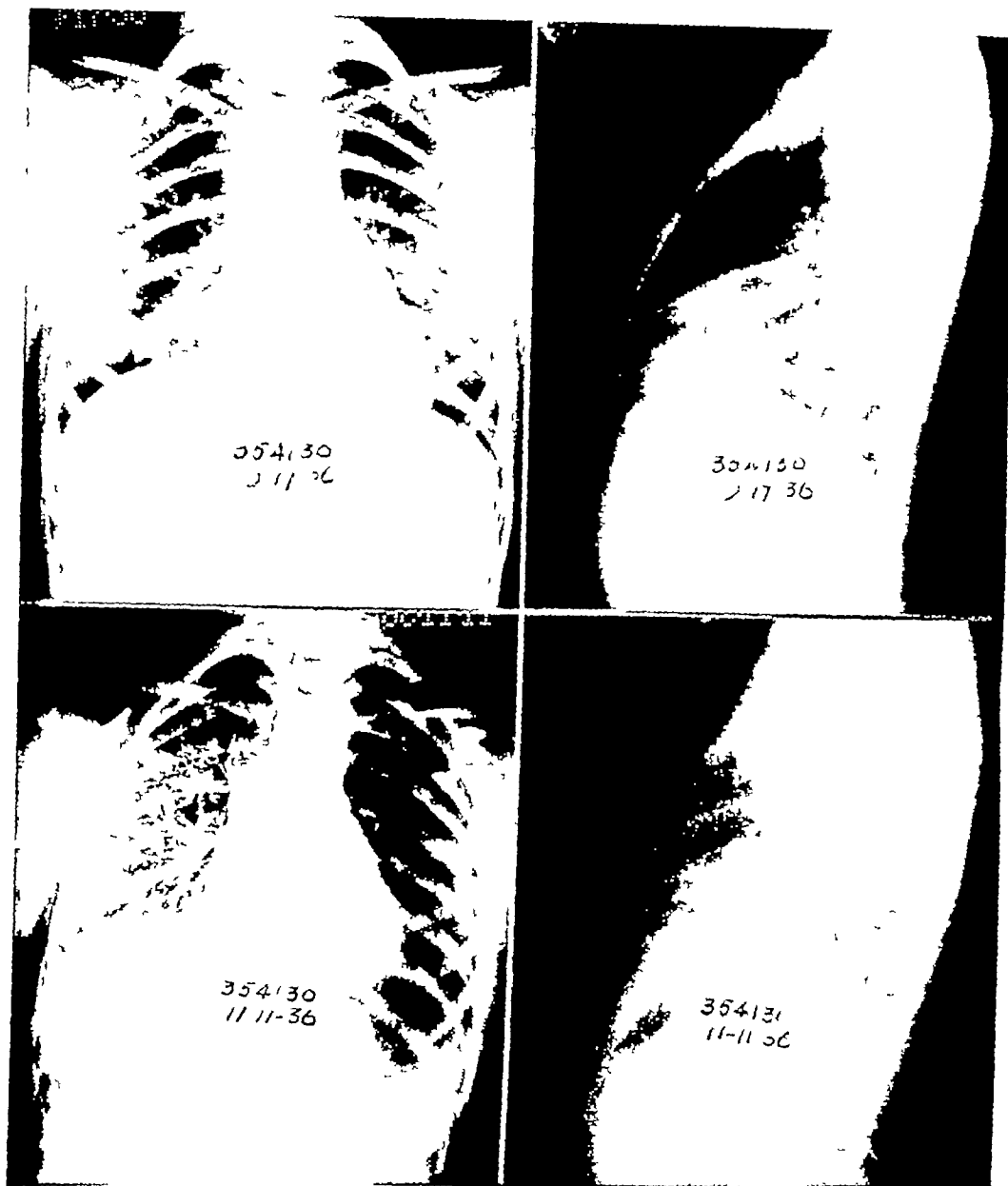
Fig 8-D (lower right) Oct 30 1935 Persistent pneumatocele with moderate increase in size Old scarring in area from previous aspiration pneumonia

ing rapid resolution of lobular pneumonia in a previously normal lung

Case 4 M C, aged 47 years Patient was well until one week after multiple tooth extractions, April 1, under gas anesthesia, when cough developed with profuse sputum The case was diagnosed as aspiration pneumonia Cough and sputum

(foul) had persisted, ease of fatigue, and discomfort in the left chest

On admission there was a lobular pneumonia, left, as shown in roentgenograms No acid-fast bacilli could be found on repeated examinations of sputum Spirochetes and fusiform bacilli were reported on May 25, 1934 On May 20, 1934, there



Figs 7-A and 7-B (upper) Case 3 Sept 17 1936 Normal lung fields
 Figs 7-C and 7-D (lower) Nov 11 1936 Normal bronchial tree (Compare with Figs 5-C and 5-D)

Nov 11, 1936, bronchial tree is normal and the child continues to grow normally

Comment—Positive evidence of a normal lung structure was available in this case prior to onset of the present illness. The development of the pneumatocele, at first multilocular, ultimately massive, has been traced, together with its spontaneous

regression. The resumption of normal bronchial pattern is striking in comparison with the earlier gross distortion effected by the pneumatocele.

There is no question here as to the absence of a congenital source. This case demonstrates graphically the production of localized cystic pulmonary disease follow-

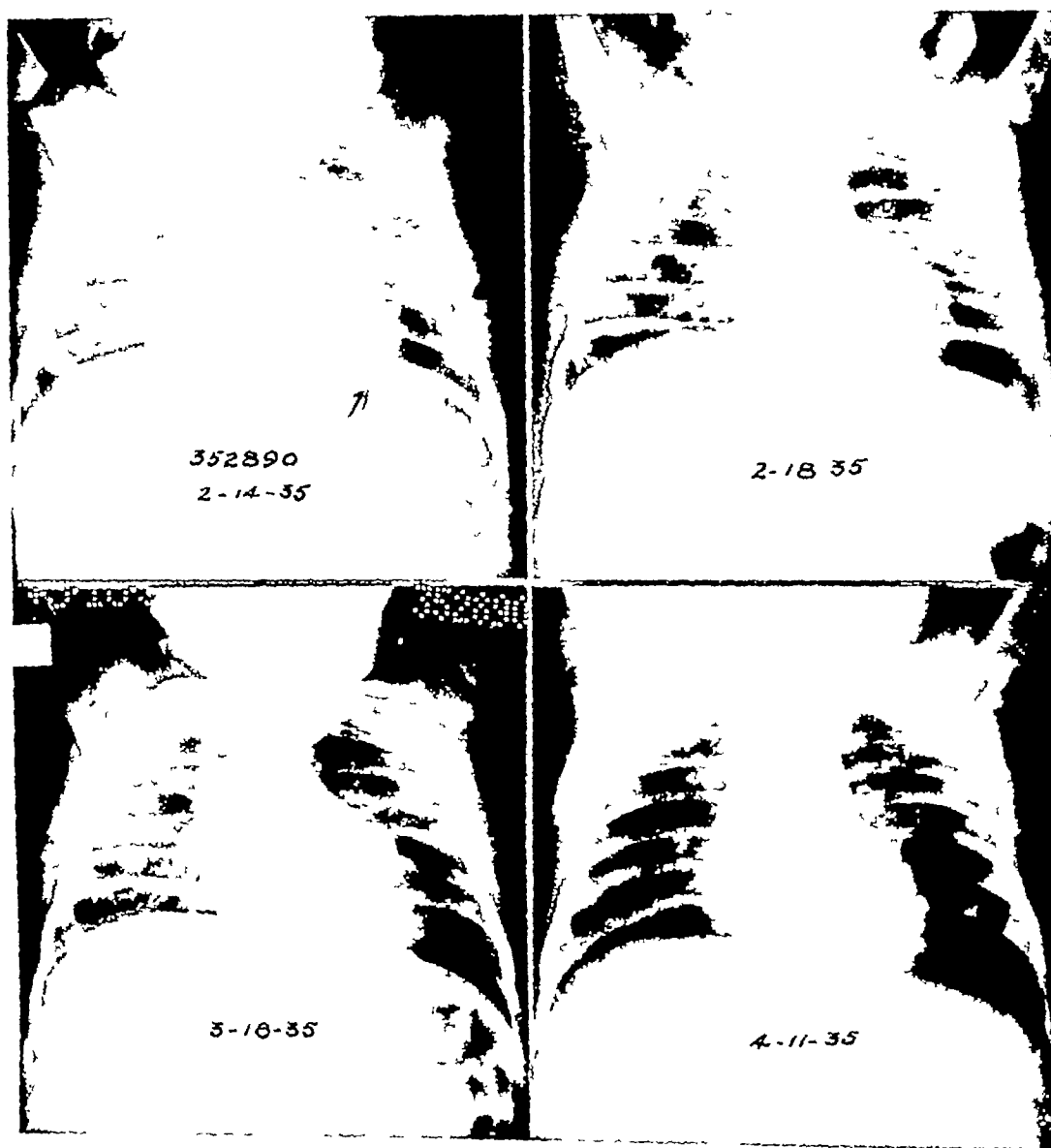


Fig 10 A (upper left) Case 6 Feb 14 1935 Admission examination resolving bronchopneumonia greater involvement on left with single pneumatocele or excavation in mid left base inflammatory changes about the wall

Fig 10 B (upper right) Feb 18 1935 Roentgenographic evidence of further resolution, persistent smooth thin walled pneumatocele left secondary lesser area appearing mesially

Fig 10 C (lower left) March 18, 1935 Pneumatocoles increased in size

Fig 10 D (lower right) April 11, 1935 Further increase in size of multiple pneumatocele left lung following resolution of bronchopneumonia

the inflammatory changes about the cystic area with increased size of the pneumatocele were observed

No cough or sputum was reported after September, 1934 Further increase in size of pneumatocele was presented in November, 1934

On Dec 30, 1935, the patient was clinically well The function of the left diaphragm was returning The pneumatocele persisted, and the peripheral scarring was minimal

Comment—A definite aspiration pneumonia, localized to the segment of the left



Figs 9 A and 9 B (upper) Case 5 Oct 25 1935 on admission Excavation or air filled cystic area in upper axillary portion of left lung with inflammatory changes about the periphery some apparent displacement of nearby lung peritruncal infiltration toward hilus, excavated or cystic area smooth walled moderate general pulmonary emphysema

Fig 9-C (lower left) Dec 11 1935 Regression of inflammatory reaction about wall of cystic area with increase in size

Fig 9 D (lower right) June 5, 1936 Pneumatocele of left apex increased in size

had been temporary left phrenic interruption with a decrease in sputum, which dis-

appeared in June Patient had no cough
On Sept 11, 1934, further regression of

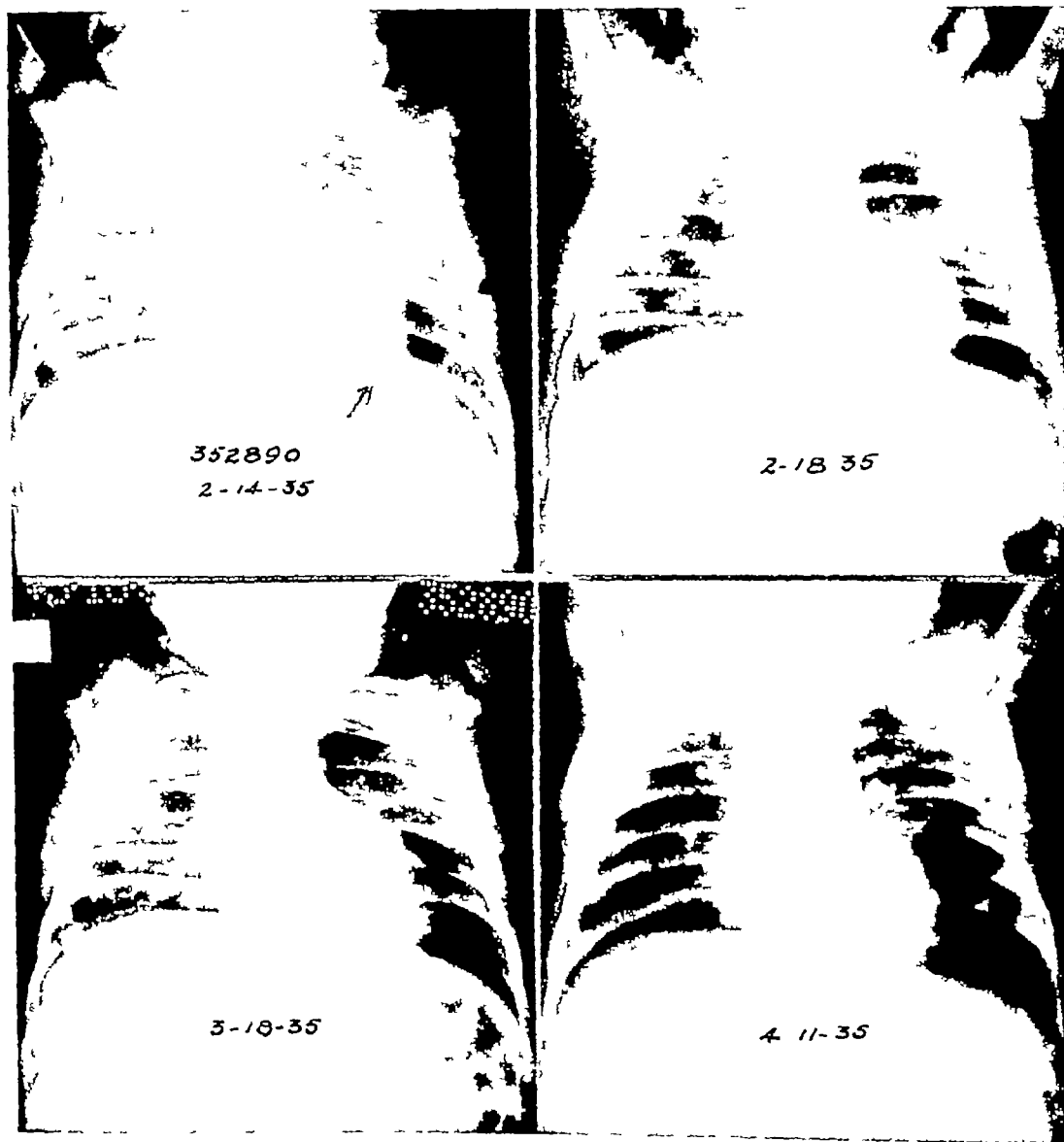


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On Dec 30, 1935, the patient was clinically well The function of the left diaphragm was returning The pneumatocele persisted, and the peripheral scarring was minimal

Comment—A definite aspiration pneumonia, localized to the segment of the left

inferior lobe supplied by the dorsal branch bronchus was demonstrated by roentgenogram. This has been followed by resolution of the lobular infection, leaving a slowly progressive pneumatocele in the scarred area. The epithelization of a central necrosis from its partially obstructed bronchus or bronchiole must be considered, as well as the greater probability of localized emphysema of a central lobule with partial check-valve obstruction of the connecting bronchus or bronchiole. The progressive enlargement of the pneumatocele indicates the latter. A congenital source is highly improbable.

Case 5 J L, male, aged 57 years. Patient suffered an injury to his nose eight years previously, followed by recurrent purulent nasal discharge. He has had chronic asthma since, the last attack of asthma being from July 15 to Sept 7, 1935, followed in a few days by chills and fever lasting ten days. He had a cough with purulent, streaked sputum, beginning the fourth day, pleuritic pain in the left chest, weakness, sweating. He had had no previous x-ray examination of the chest.

Admission roentgenologic opinion, Oct 25, 1935, was "lobular pneumonia in the left apex with excavation or pneumatocele, the latter more probable. Chronic asthma."

On Dec 11, 1935, sputum was persistently negative for acid-fast bacilli on concentrated specimens. There were no spirochetal organisms. Guinea pigs were negative. On June 5, 1936, the patient still had asthma but no sputum. Final diagnosis was acquired pulmonary pneumatocele, chronic asthma.

Comment—Intercurrent infection in a chronic asthmatic has here produced a cause for the development of a pneumatocele. The chronic asthma would afford intrapulmonary pressure changes contributing to an emphysema. No evidence is available as to the state of the lung prior to admission, but the sequence of events and subsequent course of the lung changes suggest an improbability of a congenital source for this lesion.

Case 6 G D, female, aged 3 months

Infant was well until acute onset of pneumonia in January, 1935, with slow resolution. She was admitted to the hospital on Feb 14, 1935. On Feb 18, 1935, she showed clinical improvement, by Feb 20, 1935, cough and sputum had disappeared, by Feb 23, 1935, x-ray examination showed resolution of the pneumonia, secondary pneumatocele increased in size, on March 18, 1935, asymptomatic, and on April 11, 1935, she had no symptoms—was clinically well.

Comment—The progressive increase in size of the pneumatoceles, one developing before the other, in association with a resolving lobular pneumonia in an infant previously well, can hardly be associated with a congenital origin.

This case demonstrates in the sequence of changes what we believe to be the method of development of a pneumatocele from the emphysematous intervening lobules in a lobular pneumonia.

Films prior to the pneumonia are not available, but we do not believe that a theoretical congenital source should be preferred to the more probable acquired character. Without such prior films the roentgen diagnosis may neither include nor exclude the term "congenital."

DISCUSSION

The above cases show several varieties of cystic pulmonary disease developing after acute respiratory infection, two bronchiectatic and four with focal emphysema and little or no interstitial fibrosis.

Considerable emphasis has been placed by other writers on the probable predisposition to subsequent infection which pre-existent congenital abnormalities of the lung afford. We would call attention to the fact that in most of the cases reported by others, and in all of ours, the inflammatory changes have been greatest in the lung tissue intervening between the dilated air-spaces. The "cystic" areas, themselves, have been unusually clear of evidence of infection, such as retained secretions or irregularity of wall. Our patients have had no appreciable sputum and little or no

cough after subsidence of the surrounding inflammation

If the cystic areas were the source of the disease process, they should have remained in an inflamed and exudative state for some time after the surrounding process had subsided. Such has not been our observation.

SUMMARY

1 The term "congenital" is improper in a roentgen diagnosis of cystic pulmonary disease without film evidence of such a lesion at birth

2 A congenital origin for cystic pulmonary disease is doubted as a valid premise in the majority of cases

3 Cystic pulmonary disease may be further subdivided on the basis of cause and method of development as

- I True congenital pulmonary cyst or cysts,
- II (a) Chronic interstitial pneumonitis with emphysema,
- (b) Chronic bullous emphysema,
- III Cystic bronchiectasis, and
- IV Pulmonary pneumatocele (localized alveolar or lobular ectasia)

4 The development of pulmonary pneumatocele has been demonstrated in four cases subsequent to an acute lobular pneumonia

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DISCUSSION

DR HENRY KENNON DUNHAM (Cincinnati) One of the modest men in the room said, "If they call on you, ask him whether he means this followed a pneumonitis or whether it followed pneumonia"

Peirce always said "pneumonia," and just exactly what "pneumoma" meant I think the Doctor would like to understand

I am glad to come here to speak a word of praise of this presentation. I think it is timely and worth our while and the last speaker only said that he did not agree with all Dr Peirce has said. Dr Peirce does not agree with all he said himself! The point is that he has asked a question more than he has told you something. He has shown you what he found. He has said, "Is our old solution right? Have we

not been talking glibly about congenital cysts when we do not know much about congenital cysts? Had we not better go a little slowly and find out how much of this is due to one thing and how much to another?"

The chief scientific part of this paper is the presentation of facts—a presentation of a more modern theory and the question of how much of the old we are going to discard

I am not here to answer that question any more than is Dr Peirce, but you have noticed just what he has been talking about, the same as we have at our clinic. We are asking these questions

And the next question that has to be asked is, What are you going to do about it?

DR LOUIS H CLERF (Philadelphia) My frequent appearances on the rostrum this morning would give the impression that this is my lucky day. It certainly is not when it comes to a discussion of cystic disease of the lung and pulmonary pneumatocele

I enjoyed this paper. It gives one much to think about. I am in favor of pedestal-shakers and iconoclasts, for they aid greatly in getting us to revise our notions concerning conditions about which we know too little. The term "congenital cystic disease" has been employed often when the history and clinical findings did not entirely warrant such a diagnosis. The term often has been loosely applied. I am certain that if we bear in mind what Dr Peirce has stated this morning, it will be necessary to restudy certain of our cases and revise diagnoses

DR D DUDLEY KRUPP (Martins Ferry, O) The speaker, it seems to me, used the terms "cyst" and "pneumatocele" synonymously. As a roentgenologist and pathologist, I wish to state that there is a vast difference between the two terms, therefore, the roentgen differentiation should be in accordance with the pathologic findings. In the cyst, we find a cavity

that is filled with fluid, usually of a viscid consistency. In the pneumatocele, we find an air pocket, which is caused by air distending one or more bronchioles. A cyst may be congenital, but a pneumatocele is acquired

DR CARLETON B PEIRCE (closing) In regard to the question about "cyst" or "pneumatocele," we have tried very carefully to guard in the text the use of the term "cyst" (I may have misspoken). If such a term in reference to these aerated spaces has been used, it has been qualified by saying "air-filled cystic space" or "apparent cyst," because of the fact that on the basis of accurate terminology we do not consider them cysts

We emphasized in the opening paragraphs of the paper that there is no objection to the use of "cyst" in those individuals within whom such spheroid spaces contain fluid. The one case which I mentioned having seen with Dr Rowe (he has told me to-day that this patient is now a senior medical student), the few cases which Kunz cited, and others reported subsequently are unquestionably congenital pulmonary cyst

I would again emphasize that we, personally, have not seen any, nor do we find reported more than two cases of "honey-comb lung" or multiple cystic pulmonary disease in which both air-filled and fluid-filled "cystic" spaces were found simultaneously. Logically such a state of the lungs would be expected in congenital disease with rupture and subsequent aeration of some of the cysts. We cannot believe that multiple congenital pulmonary cysts could have ruptured universally and become aerated

If all cases presenting these multiple, air-filled "cystic" spaces are "congenital" cystic pulmonary disease, why are there so few individuals who show both air-filled and fluid-filled spaces?

The cases of multiple involvement which we present in the paper, and which I omitted this morning because of the shortness of time, have been referred to by

Dr Chamberlain¹ They illustrate our opinion on the above question (Cases 1 and 2 presented)

In these we believe that the lobular pneumonia has been accompanied by multiple alveolar to lobular ectasia of intervening areas and sufficient suppurative process to induce the pneumonitis and chronic bronchitis to cause the condition to be persistent and progressive

In the other four we have no tissue studies for pathologic proof Fortunately for the patients, unfortunately for us, they are clinically well But we do not believe their condition can be of congenital origin

The terminology in the literature is confusing We have attempted to clarify our concept of the mechanics of production of these changes on whether they be the solitary air-tumor or "pneumatocele" (probably a lobular ectasia), multiple involvement (alveolar ectasia, widespread peripheral bronchiectasis, or either, associated

with interstitial pneumonitis), or the single true congenital cyst filled with fluid On close analysis, most of the cases previously reported would seem to fall in our Groups II and III

We are honored by Dr Clerf's comments I hope I am not too much a nihilist or a "pedestal-shaker" But the question, "Can all these be congenital in origin?" has actually bothered us Consequently when the youngster (Case 3) presented the sudden development of pneumatocele after a known pneumonia in a previously normal lung, we were further aroused Her subsequent story has confirmed us in our skepticism The others have served as additional evidence in support

As Dr Dunham has said, we are asking the question of ourselves as well as of others We know that in the past we have made the diagnosis "congenital cystic pulmonary disease" without concern We now believe that we were in error as to the "congenital" character

¹Dr Chamberlain's discussion was not returned for publication

not been talking glibly about congenital cysts when we do not know much about congenital cysts? Had we not better go a little slowly and find out how much of this is due to one thing and how much to another?"

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DR LOUIS H CLERF (Philadelphia) My frequent appearances on the rostrum this morning would give the impression that this is my lucky day. It certainly is not when it comes to a discussion of cystic disease of the lung and pulmonary pneumatocele

I enjoyed this paper. It gives one much to think about. I am in favor of pedestal-shakers and iconoclasts, for they aid greatly in getting us to revise our notions concerning conditions about which we know too little. The term "congenital cystic disease" has been employed often when the history and clinical findings did not entirely warrant such a diagnosis. The term often has been loosely applied. I am certain that if we bear in mind what Dr Peirce has stated this morning, it will be necessary to restudy certain of our cases and revise diagnoses

DR D DUDLEY KRUPP (Martins Ferry, O) The speaker, it seems to me, used the terms "cyst" and "pneumatocele" synonymously. As a roentgenologist and pathologist, I wish to state that there is a vast difference between the two terms, therefore, the roentgen differentiation should be in accordance with the pathologic findings. In the cyst, we find a cavity

that is filled with fluid, usually of a viscid consistency. In the pneumatocele, we find an air pocket, which is caused by air distending one or more bronchioles. A cyst may be congenital, but a pneumatocele is acquired

DR CARLETON B PEIRCE (closing) In regard to the question about "cyst" or "pneumatocele," we have tried very carefully to guard in the text the use of the term "cyst" (I may have misspoken). If such a term in reference to these aerated spaces has been used, it has been qualified by saying "air-filled cystic space" or "apparent cyst," because of the fact that on the basis of accurate terminology we do not consider them cysts

We emphasized in the opening paragraphs of the paper that there is no objection to the use of "cyst" in those individuals within whom such spheroid spaces contain fluid. The one case which I mentioned having seen with Dr Rowe (he has told me to-day that this patient is now a senior medical student), the few cases which Kunz cited, and others reported subsequently are unquestionably congenital pulmonary cyst

I would again emphasize that we, personally, have not seen any, nor do we find reported more than two cases of "honey-comb lung" or multiple cystic pulmonary disease in which both air-filled and fluid-filled "cystic" spaces were found simultaneously. Logically such a state of the lungs would be expected in congenital disease with rupture and subsequent aeration of some of the cysts. We cannot believe that multiple congenital pulmonary cysts could have ruptured universally and become aerated

If all cases presenting these multiple, air-filled "cystic" spaces are "congenital" cystic pulmonary disease, why are there so few individuals who show both air-filled and fluid-filled spaces?

The cases of multiple involvement which we present in the paper, and which I omitted this morning because of the shortness of time, have been referred to by



Fig 2 Case 2 C S No 84298, male 38 years of age, was admitted to the Emergency Department on Jan 5, 1932, with a subglenoid dislocation of the left humerus. He was under the influence of alcohol and knew nothing about the cause of his accident. Roentgen rays showed a dislocation of the head of the humerus with a cyst like shadow. After reduction this cyst like area was no longer apparent.



Fig 3 Case 3 C K., No 94788, male, 71 years of age came to the Emergency Division on Oct 14, 1934. He had slipped on the top step of a stairway and had fallen down fourteen steps hitting on his right shoulder. There was a subcoracoid dislocation with fracture of the inner third of the clavicle. This was confirmed by roentgen ray. After reduction there was observed the appearance of a cyst like shadow at the upper end of the humerus.

RADIOGRAPHIC APPEARANCES ABOUT THE SHOULDER JOINT, WITH ESPECIAL REFERENCE TO CYST-LIKE SHADOWS

CLINICAL CASES

By JOHN J MORTON, M D , and WALTER W FRAY, M D , Rochester, N Y

From the Department of Surgery and the Division of Radiology, Department of Medicine, University of Rochester School of Medicine and Dentistry

FOR several years we have been consulted in regard to queer appearances in roentgenograms of the bones about the shoulder joint, and especially in those of the upper end of the humerus. Physicians have often been confident that they were dealing with cystic changes in the humerus, clavicle, or scapula, with giant-cell tumors at the upper end of or in the tuberosities of the humerus. On occasion there have been enough symptoms and signs, together with these radiographic appearances, to warrant exploratory incision

by the attending surgeon. The fact that these unusual films also may be obtained after injury to the shoulder has led to suits for compensation in some instances.

Careful study of the films before and after a negative exploration in one case led us to the consideration that perhaps the position of the bones was not that which we had been accustomed to interpret. Repeated observations in dislocations of the humerus with consequent abnormal positions of the bones have served to substantiate this view. Following some forms of trauma the patient is not able to get his shoulder into an ideal contact with the radiographic plate and distortion of the usual roentgenogram is the result. In other instances when long continued disuse of the shoulder (especially in adduction) has supervened the calcium has been withdrawn from the bony structures about the joint and in consequence the thinner areas appear as cystic spaces in contrast to the more dense cortex. Several examples of these unusual appearances are here presented with brief histories under each illustration (Figs 1-7).

When we had acquired experience from observations on some of our clinical cases, it seemed advisable to determine what roentgen-ray appearances might be expected when the humerus was rotated through varying positions. This subject will be presented in the paper by one of us (W W F) which follows.

From a study of these patients it is apparent that trauma, infection, and disuse may cause symptoms referred to the shoulder joint. Roentgen-ray examination may reveal peculiar appearing areas in the bones about this joint. The physician must be guarded in his interpretation of these films. The diagnosis should not be



Fig 1 Case 1 C R No 83 333 female 58 years of age was admitted to the emergency department on Dec 6 1933. She had fallen down the cellar stairs striking the left shoulder and left side of her head. There was pain on movement of the shoulder. Examination showed a forward displacement of the left shoulder. The arm was held close to the side. There was a swelling over the outer third of the clavicle. The lower angle of the left scapula showed winging. A fracture could be palpated at the outer third of the clavicle. Roentgen rays showed a complete fracture of the clavicle, outer third with overriding of the fragments. A peculiar cyst like appearance was noted in the head of the humerus (as shown). Reduction and fixation were done in the usual way. The result of the treatment was excellent.

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ture of the surgical neck of the humerus. There was a shadow with a definite outline which suggested a cyst or giant-cell tumor. Subsequent roentgen ray films from different angles proved that this appearance was due to a rotation of the greater tuberosity into an anterior position.

Fig 6 Case 6 H. C., No 74,066, male, 48 years of age, was admitted to the Orthopedic Department with a history of pain in the right shoulder of five months' duration. There was no history of injury. General examination was negative. There was slight tenderness beneath the tip of the right acromion process. The right shoulder could not be abducted beyond 90° without pain. External rotation was about three fourths normal. Roentgen ray examination showed a decrease in density about both tuberosities. There was also what appeared to be a cystic area in the base of the coracoid process. A diagnosis of subacute subdeltoid bursitis was made. The appearances in the humerus resulted from disuse calcium withdrawal. The cystic appearance of the coracoid was due to the position. It disappeared on views taken from another angle.



Fig 7 Case 7 A. P., No 81,257 female, 43 years of age, was seen here first on Oct 17, 1933. She had been in an automobile accident on Nov 28, 1931. At that time she was holding out her left hand to indicate a left turn when another car crashed into her auto from behind. She was thrown against the door. There was soreness and stiffness of the shoulders and neck that night. She was under the treatment of her local doctor for two months following this without relief. In January, 1932 roentgen ray films were taken. Pain had been present in her shoulder and neck ever since the accident. She had not been able to use her left arm for even the lightest movements without pain. She could not get her left hand up to her hair. Pain kept her awake at night. There had been shortness of breath, nervousness and occasional hysterical episodes.

Examination revealed an obese woman apparently in good health. General examination was normal for her age. The left shoulder was painful around the outer end of the clavicle and the acromion. All motions were apparently much restricted, especially abduction. There was atrophy of the left upper arm muscle. No sensory or vasomotor changes were noted. Roentgen ray examination showed areas of decreased calcium content over the head of the humerus. There was a blotchy distribution of calcium all around the shoulder joint, in the outer end of the clavicle, and in the scapula as well as in the humerus. There was slight evidence of arthritic change around the glenoid region.

This patient had been told that she had a giant-cell tumor or a cyst of the upper end of the humerus. There was a lawsuit involved with the company which carried auto insurance on the other machine. The claim was made that trauma had caused development of a cyst or giant-cell tumor in the injured humerus.



Fig 4 Case 4 M K No 69,917, female, 33 years of age, was admitted to the Strong Memorial Hospital on Feb 2 1933 complaining of pain in the right shoulder Six years previously she began to have severe aching pain in the right shoulder and right side of the neck, not relieved by treatment There was no history of focal infection or trouble with other joints On examination she showed atrophy of the right supraspinatus infraspinatus, and deltoid muscles There was point tenderness at the tip of the acromion process Motion of the right shoulder showed good range but was slightly painful Roentgen ray examination of the humerus showed what appeared to be a large bone cyst in the head of the humerus There was a calcified spot in the region of the subdeltoid bursa In another view the cyst like area did not show well but there appeared to be a loss of density of the greater tuberosity and the calcified areas in the bursa were more pronounced



Fig 5

Fig 6

Fig 5 Case 5 L C, No 44,274, female, 52 years of age fell on the ice March 25 1934 striking her left shoulder There was immediate pain and swelling of the shoulder Examination showed exquisite tenderness about the head of the humerus, swelling and ecchymosis Roentgen ray examination revealed a frac

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ture of the surgical neck of the humerus. There was a shadow with a definite outline which suggested a cyst or giant-cell tumor. Subsequent roentgen ray films from different angles proved that this appearance was due to a rotation of the greater tuberosity into an anterior position.

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Fig 7 Case 7 A P No 81 257 female, 43 years of age, was seen here first on Oct 17 1933. She had been in an automobile accident on Nov 28 1931. At that time she was holding out her left hand to indicate a left turn when another car crashed into her auto from behind. She was thrown against the door. There was soreness and stiffness of the shoulders and neck that night. She was under the treatment of her local doctor for two months following this without relief. In January, 1932 roentgen ray films were taken. Pain had been present in her shoulder and neck ever since the accident. She had not been able to use her left arm for even the lightest movements without pain. She could not get her left hand up to her hair. Pain kept her awake at night. There had been shortness of breath, nervousness and occasional hysterical episodes.

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reached until a careful appraisal of all symptoms and signs has been made. If the roentgen rays seem to offer a possible diagnosis of bone cyst or giant-cell tumor, it is well to remember the characteristics of these lesions. The bone cyst is likely to be in the diaphysis below the epiphyseal line. The cortical bone over it becomes thinned out by pressure. The picture is of a clean-cut area visible in every position of the bone. The giant-cell tumor of the humerus occupies the angle between the upper and lower epiphyseal lines. It is of a peculiar type in the humerus, the so-called chondromatous giant-cell tumor described by Codman (1). It differs from the giant-cell tumor in other bones by the fact that it does not actually destroy the bone to the articular cartilage but is restricted to the

region of the greater tuberosity. This breaks the rule for giant-cell tumors in other bones because the tumor does not extend into the head of the humerus much beyond the epiphyseal line. There is present also a thickened strut of normal cortical bone just below the tumor. In any case in which a doubtful cyst-like lesion is exposed by the roentgen-ray examination, the influence of position should be considered. One of us (W W F) has made a thorough study of the radiographic appearances about the shoulder joint from many different angles. The results of this study will be presented in another paper.

REFERENCE

- (1) CODMAN, E. A. Epiphyseal Chondromatous Giant-cell Tumors of the Upper End of the Humerus. *Surg., Gynec. and Obst.*, 1936, 52, 543-548.

THE EFFECT OF POSITION ON THE PRODUCTIONS OF CYST-LIKE SHADOWS ABOUT THE SHOULDER JOINT

By WALTER W FRAY, M D , Rochester, N Y

THE shoulder as a joint of the universal type displays a wide range of motion in all three planes of space. The degree of its mobility is reflected by the range of flexion and extension of the arm through 180 degrees (hyperextension adding about 45 degrees of additional mobility), by the range of abduction through 90 degrees with an additional 90 degrees if rotation of the scapula is taken into consideration, by the extent of horizontal abduction and adduction through 90 degrees, and finally by the degree of internal and external rotation, which in a position of horizontal abduction amounts to about 90 degrees. The radiographic appearance will, of course, vary with the position of the arm and shoulder employed during the technic. It is the purpose in the present study to relate the radiographic appearance with the anatomic position and to demonstrate the manner in which misinterpretation may arise due to the employment of faulty technic or to a lack of familiarity with normal roentgenologic appearance when a restricted or an unusual technic must be followed.

The common texts describing x-ray technic present a confusing picture to the novice in this field, chiefly because of the diversity of technics described. The positions recommended by Hirsch (1), 1920, are anteroposterior films of the shoulder secured on a 45° angle block. The arm is placed at the side of the body with the forearm midway between supination and pronation. In this position, therefore, the thumb is uppermost and the internal epicondyle points medially and slightly posteriorly. With the shoulder in this position, Hirsch states that the central ray should be directed from a point four inches above the shoulder joint if the shoulder joint itself is the joint of main interest, while if the acromioclavicular joint is desired, the position of the patient remains

the same but the central ray is directed from a point four inches below the joint. Secondly, Hirsch recommends a postero-anterior position with the arm held in a true anatomic position, that is, with the palm of the hand held in the supinated position. A third position recommended by Hirsch is the infero-superior position, placing the film or cassette on top of the shoulder and directing the rays upward and inward through the axilla. Jerman (2), 1928, describes two positions (postero-anterior and anteroposterior), the anteroposterior position with the patient supine, the arm adducted to the side of the body, and the hand resting over the abdomen. The illustration, however, which accompanies the description of the position does not show the arm in the internally rotated position which results when the hand is placed over the abdomen. The postero-anterior position is described by Jerman with the patient prone, the face being turned toward the normal side, and the arm adducted to the side of the body. The focus is stated to be over the outer end of the clavicle. Rhinehart (3), 1936, recommends the true anteroposterior anatomic position as the standard position if there are no bandages present and pain does not prevent its use. He states that a lateral film is obtained, at least as regards the humerus, when the arm is internally rotated, by throwing the hand in a pronated position over the chest. Special technics are mentioned by Rhinehart in order to obtain lateral films of the upper humerus in the event that there are no restricting bandages and excessive pain is not present. These special technics involve placing the film either in the axillary region, taking a supero-inferior type of film, or placing the film on top of the shoulder when the arm is abducted from the side of the body, the central ray entering through the axillary region at right-angles to the film.

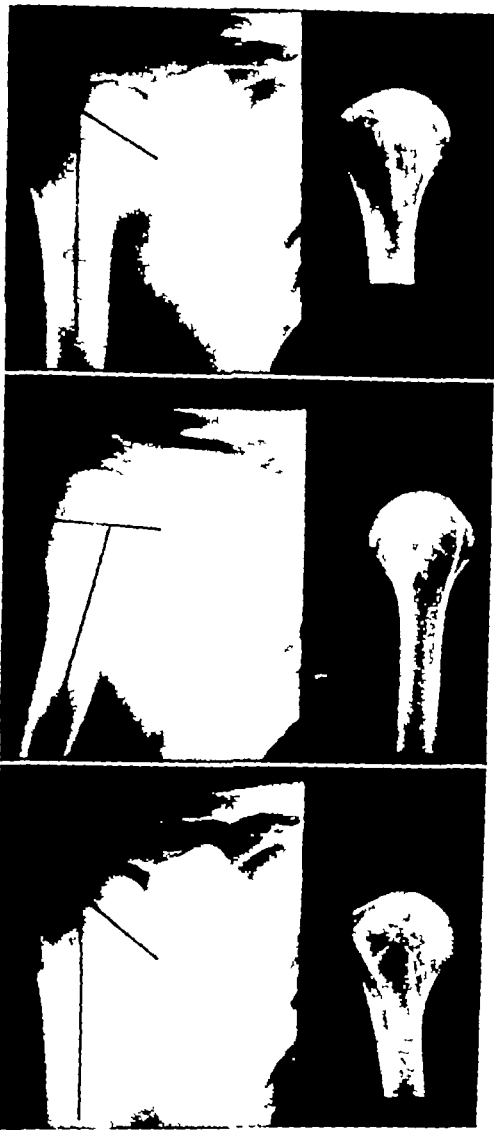


Fig 1 Effect of internal and external rotation. Comparison of shoulder films of normal individual with dried specimen

(A) Anatomical position. The greater tuberosity is brought into full salience along the outer aspect of the upper humerus. The lesser tuberosity is seen distinctly, due to its position on anterior aspect of the bone. The articular convexity faces upward and medially. The epiphyseal line forms an acute angle of 55-60° with the long axis of the shaft.

(B) Extreme internal rotation. The lesser tuberosity is outlined in full salience along the inner aspect of the upper shaft; the greater tuberosity disappearing due to its anterior position. The head faces upward and the epiphyseal line forms a slightly obtuse angle with the long axis of the shaft.

(C) Extreme external rotation. The greater and lesser tuberosities are partly superimposed upon one another along the outer aspect. The articular convexity faces strongly inward and the lower articular margin of the head lies on the same plane as the lower articular margin of the glenoid.

some one region or portion of the humerus or scapula

ANALYSIS OF EFFECTS OF ROTATION ON ROENTGENOLOGIC APPEARANCES WITH AND WITHOUT THE ABDUCTION OF THE ARM

Changes Produced by Rotation when Arm is Held in the Adducted Position—The films were obtained with the patient supine. For the first exposure the arm, placed parallel with the long axis of the body, was rotated inward, with the forearm placed between the back of the patient and the table top in a position of hyperextension (Fig 1). This position brings the bicipital groove near the medial aspect of the upper humerus. The position is an unusual one, the lesser tuberosity being seen in profile exceptionally well. The greater tuberosity, due to its anterior position, is poorly visualized except for its margin at the bicipital groove. The lower articular margin of the head is noted at the mid-level of the glenoid. The main articular portion of the head is directed cephalad with the epiphyseal line running at a right-angle to the shaft of the bone or tilting slightly away from the scapula side. As the humerus externally rotates to the usual anatomic position, the bicipital groove shifts toward the lateral aspect of the bone and the greater tuberosity is visualized in profile (Fig 1). The outline of the lesser tuber-

We have taken a series of 18 films of a normal shoulder to illustrate the changing character of the x-ray shadows with alterations in position. We have purposely taken these films through the full range of flexion and extension, adduction and abduction, and internal and external rotation. From this study we have gained much in experience and we feel that the establishment of a routine type of technic is highly desirable for the average type of case. Special positions have been found to be advantageous when a restricted study is desired, concentrating attention particularly upon

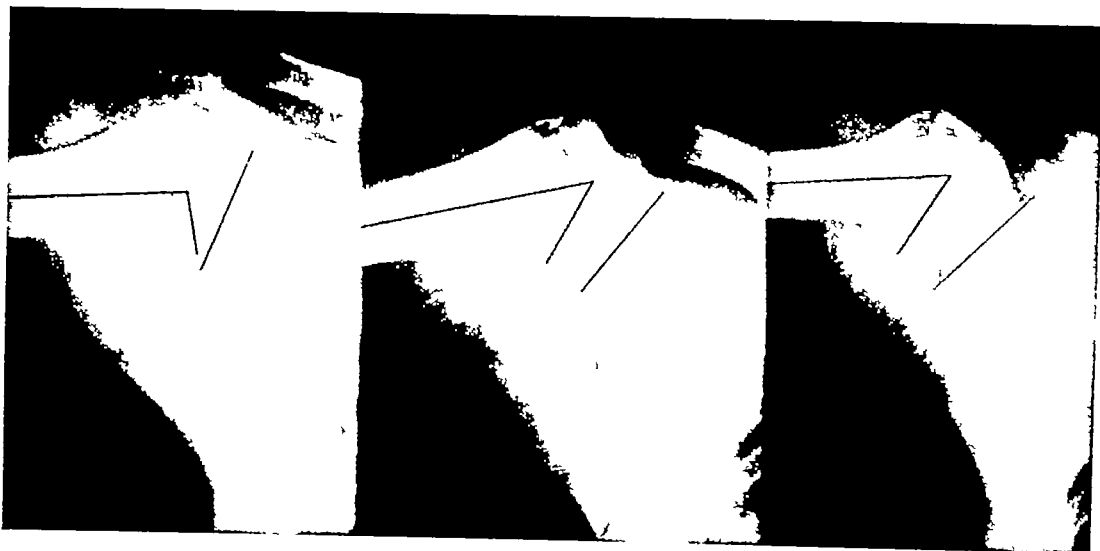


Fig 2 Effect of rotation at 90° abduction

(Left) Extreme internal rotation Plane of epiphyseal line forms an obtuse angle with the shaft
 (Middle) Anteroposterior position without rotation Plane of epiphyseal line forms an acute angle with shaft
 (Right) Extreme external rotation Plane of epiphyseal line forms an acute angle with shaft Note that the effect of rotation upon the humerus is practically identical with that observed in adduction The scapular relations vary, however The base of the coracoid appears as a cyst during internal rotation This process is brought out into good relief by external rotation and is thrown upward between the shadows of the outer clavicle and acromion The head covers larger portions of the acromion as external rotation is employed, the extent of abduction remaining constant

osity is largely lost except for an indistinct margin at the bicipital groove The lower articular margin of the head is observed at the level of the junction of the lower and middle third of the glenoid The plane of the epiphyseal line forms an angle of approximately 60 degrees with the long axis of the shaft

The position obtained when the hand is placed over the abdomen with the arm to the side is an intermediate one between the anatomic anteroposterior position and extreme internal rotation The anatomic relationships as shown in the radiograph resemble the anteroposterior film in general appearance, but the greater tuberosity is not observed in full salience There is always the danger of the arm being taken in a position with some forward flexion, a condition which favors the production of confusing shadows The angle between the plane of the epiphyseal line and the long axis of the humerus changes from 60 degrees for the true anatomic position to 75 degrees for the partially internally rotated position

With extreme external rotation the margins of the bicipital groove become sharply defined at the extreme outer aspect of the bone, the greater tuberosity having rotated to a posterior position and is seen only partly in profile (Fig 1) The angle between the epiphyseal line and the shaft of the humerus decreases to approximately 50 degrees The lower articular margin of the head lies on practically the same plane as the inferior margin of the glenoid

Effect of Rotation when Arm is Held in 90° Abduction with Humerus at Right-angle to the Long Axis of the Body—Internal rotation changes the relationship between articular surfaces of the head and the glenoid, but the general appearance of the upper end of the humerus is much the same as that observed when the arm is adducted to the side of the body except that the degree of internal rotation is somewhat less and the lesser tuberosity is not brought into full salience as a result (Fig 2) As external rotation is employed, the changes observed at the upper humerus are similar

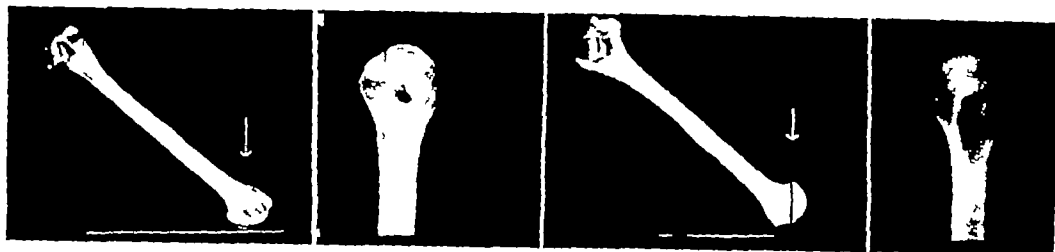


Fig 3

Fig 4

Fig 3 Anatomical basis for appearance of roentgenologic shadows produced by combined movement of flexion and internal rotation

(Left) Humerus oriented at 45° forward flexion and 90° internal rotation. Note that the plane of the epiphyseal line (indicated by black line) lies parallel to the film surface (indicated by white line). The head looks directly downward toward the film.

(Right) A radiograph obtained with the central ray as shown by arrow. The articular margins of the head are cast upon the film as a circular shadow, the margins simulating the walls of a cyst. The epiphyseal line is absent. The margins of the greater and lesser tuberosity are superimposed upon those of the head to permit further confusion. This position of the arm is obtained whenever the arm is strapped across the chest in a Velpeau bandage.

Fig 4 Anatomical basis for appearance of roentgenologic shadows produced by combined movement of flexion and external rotation

(Left) Humerus oriented at 45° forward flexion and 90° external rotation. Note that the epiphyseal line (indicated by black line) is now perpendicular to the film surface (white line). The articular surface of the head is directed cephalad.

(Right) Radiograph obtained with central ray as shown by arrow. The epiphyseal line being at a right-angle to film surface casts a shadow across the extreme upper end of the shaft. The convexity of the head is directed away from the shaft. The lesser tuberosity casts a pointed salience along the lateral aspect of the bone while the shadow of the greater tuberosity is largely lost, being visualized through the upper shaft.

to those seen when the arm is held adducted to the side.

When the arm is directed vertically upward in a position of extreme abduction, rotation becomes more limited with less marked changes observed at the upper end of the humerus.

Effect of Abduction on Relations of Scapula—While the general appearance of the humerus remains much the same during abduction and adduction (provided the same degree of rotation is maintained), the relations between the shadows cast by the various portions of the scapula, clavicle, and humerus show marked changes. With the arm adducted to the side, a line drawn between the superior and inferior glenoid tubercle is directed nearly vertically downward and the vertebral border of the scapula runs nearly parallel with the spine. The coracoid is visualized very poorly, its base casting an oval shadow resembling the bony outlines of a cyst while the tip of the process overlies the glenoid. The scapular spine lies at a high level above the plane of the coracoid. The supraspinous fossa is poorly visualized, measuring less than a centimeter in width, due to the angle at

which its outlines are cast on the film. The acromion at its outer end partly overlies the humerus. The outer end of the clavicle appears relatively slender and straight, its angle being entirely missed in this position. With abduction the shadow of these structures shows a shift in relationship (Fig 2). The coracoid overlies the scapular spine and the base of the acromion when the arm is internally rotated. It tends to be thrown above the acromial level as the arm undergoes external rotation and the outer end of the clavicle presents its angle or curve with increasing external rotation. With extreme external rotation, the coracoid is observed between the base of the acromion and the outer end of the clavicle. The outer portion of the acromion overlies a larger portion of the shadow of the upper humerus than when the arm is abducted. This effect is likewise increased by external rotation. In the position of extreme abduction with the arm directed vertically upward, the coracoid—both its base and process—is well visualized, the shadow being noted medial to the plane of the scapular spine, with its process directed upward and laterally near the shadow of the acromioclavicular joint.

vicular joint The acromion is visualized angle The plane of the glenoid forms an only through the humerus except for the angle of more than 45 degrees with the

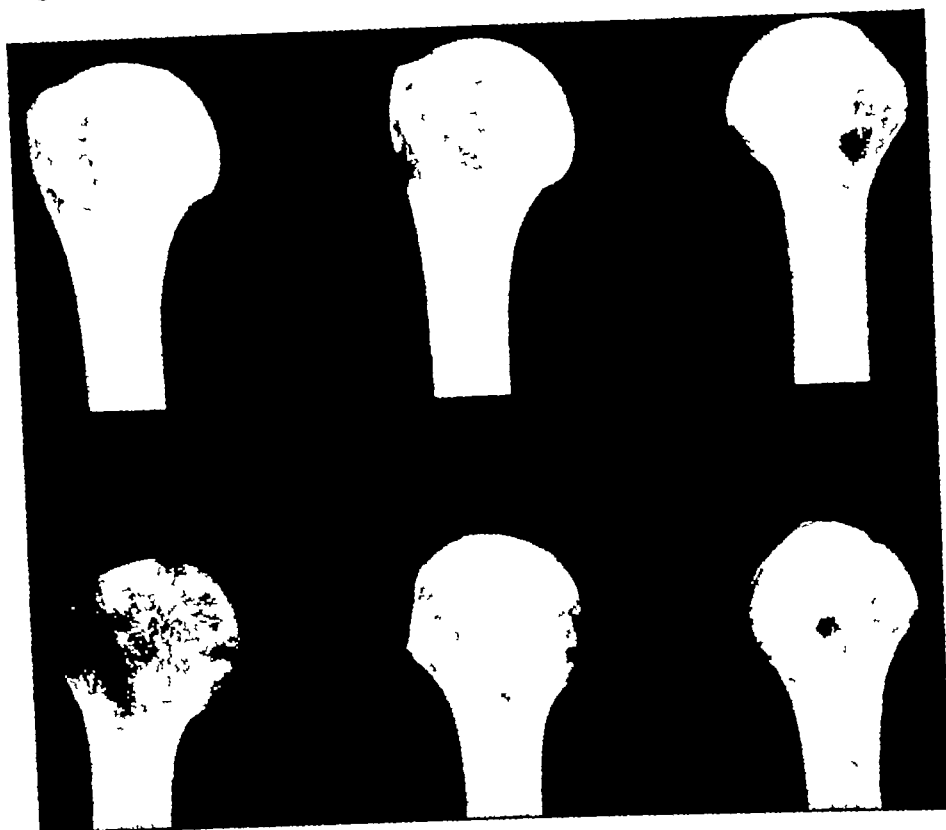


Fig 5 Films of bone specimen (right humerus) showing effect of change in position on roentgenologic appearances In each case the bone is oriented so that the right side of the humerus faces the axillary region (medially)

(Upper left) Straight anteroposterior or anatomical position The greater tuberosity lies in maximum salience on the outer aspect of the bone The lesser tuberosity is indistinctly visualized (because of its anterior position) just below the epiphyseal line over the central portion of the upper shaft The head faces medially

(Upper central) Extreme external rotation The greater tuberosity has been turned to a more posterior position while the lesser tuberosity may be identified far laterally overlying a portion of the greater tuberosity The head faces medially

(Upper right) Extreme internal rotation The lesser tuberosity is brought into salience along the medial border while the shadow of the greater tuberosity is largely lost being visualized only through the upper shaft because of its anterior position The convexity of the head now faces away from the axilla

(Lower left) Forty five degrees of forward flexion without rotation Position of the arm is similar to upper left except for flexion The shadow of the lesser tuberosity is thrown upward in the notch between the greater tuberosity and the head Note the tendency for the upper humerus to appear cystic

(Lower middle) External rotation (90°) and forward flexion (45°) The lesser tuberosity is cast into salience on the lateral aspect of the bone while the greater tuberosity is visualized indistinctly through the upper shaft due to its posterior position The head faces vertically upward

(Lower right) Internal rotation (90°) and forward flexion (45°) The head looks downward toward the film its articular margins casting a shadow simulating a cyst The two tuberosities are superimposed over the circular outline of the head and portions of their margins may coincide with those of the head The straight line of increased density running vertically downward through the inner portion of the outline of the head is cast by the lateral margin of the bicipital groove The curved line representing the lower border of the cyst like shadow is cast by the inferior articular margin of the head

region about the joint The outer one-third of the clavicle is well seen with its spine The supraspinous fossa appears much broader, being brought into full

salience, an effect quite different from that obtained when the arm is held in adduction.

Postero-anterior films of the shoulder are usually not indicated since it places the scapula some distance from the film. However, one position was found to be use-



Fig 6 Effect of position of tube focus on roentgenologic relationships

(Upper) Tube focus four inches above shoulder joint. The superior articular margin of the head is cast entirely free from the shadow of the acromion. The outer end of the clavicle overlies the acromion with the result that the acromioclavicular joint is not well defined. The clavicle lacks its usual curve.

(Middle) Tube focus directly over the shoulder joint. A small portion of the superior articular margin of the head overlaps the acromion. The clavicle is cast at a somewhat higher level with less overlapping of acromion and clavicle. The coracoid tuberosity is partly brought into salience. The curve of clavicle is largely lost.

(Lower) Tube focus four inches below shoulder joint. While the shoulder joint is not clearly defined due to superimposed shadows of the head

ful, presenting much the same information obtained with the arm in full abduction. This is obtained by rolling the body of the patient in the supine position in an oblique plane with the axilla applied closely to the film surface, the central ray being directed downward through the shoulder at right-angles to the film surface.

EFFECT OF ROTATION ON ROENTGENOLOGIC APPEARANCE OCCURRING DURING FLEXION AND EXTENSION OF THE ARM

The various portions of the scapula undergo very little shift in relationships until attempts at extreme flexion are employed. At moderate forward flexion (45 degrees from the frontal plane of the body), the changes are limited to the appearance of the humerus. These latter changes however, are marked, varying greatly with the degree of rotation. In the position of internal rotation (with 45 degrees of forward flexion) the plane of the epiphyseal line is approximately parallel with the film (Fig 3). The epiphyseal line, as a result, is not visualized. The articular margins of the head cast a circular shadow which is seen, superimposed upon neck and tuberosities. On the film it appears as a cyst, the articular margins of the head simulating the walls of the cyst. The superior margin of the greater tuberosity lies near the superior articular margin of the head and may even lie above it, depending upon the amount of flexion employed. It should be noted that internal rotation and forward flexion result whenever the forearm is applied to the anterior aspect of the chest and bandaged in the usual manner with a Velpeau or a Sayre bandage.

and outer clavicle upon adjacent structures, the acromioclavicular joint is outlined exceptionally well. The shadows of the acromion and outer clavicle are widely separated. Both the coracoid tuberosity and the curve of the clavicle are best seen on this type of film. A low tube focus favors definition of the outer end of the clavicle, acromioclavicular joint and acromion, while a high tube focus best defines the outline of the shoulder joint. A much lighter exposure is desirable for definition of the acromioclavicular joint than has been employed here. This may be accomplished by decreasing exposure factors or, better, by the use of a wedge filter over this region of the film.

With external rotation (maintaining the 45° forward flexion), the plane of the epiphyseal line becomes perpendicular to the film (Fig 4). The notch between the head of the greater tuberosity, representing the anatomical neck, is well visualized. The outlines of the greater tuberosity are seen very indistinctly. The lesser tuberosity is thrown over laterally into full salience.

From an analysis of these positions the causes for the production of confusing shadows become apparent. Forward flexion combined with internal rotation throws the face of the head downward toward the film, a position favoring the production of cyst-like shadows at the upper end of the humerus. If partial forward flexion is at all marked (such as results from strapping the forearm across the chest), large round shadows simulating cysts are certain to occur on the film.

Since this is a common position of the arm for many of the common injuries of the arm and shoulder, it behooves the roentgenologist to recognize the manner in which the films have been obtained. If any doubt exists as regards the interpretation of the films, an additional film eliminating extension and internal rotation should be obtained, or, if this is impossible, the opposite or normal side should be taken in a position identical with that of the injured side.

For routine purposes anteroposterior films of the shoulder joint should be taken with the arm held in the true anatomic position or as close to this position as circumstances permit (the palm of the hand being directed anteriorly). If removable bandages or slings are present, the arm should be sufficiently freed to eliminate internal rotation and forward flexion. Abduction of the arm is not apt to produce shadows difficult to interpret. The relations between the axis of the humerus and the scapula will, of course, vary with the degree of abduction, but cyst-like shadows will not appear unless internal rotation and forward flexion are permitted. Since, however, there is a tendency on the part of the

patient to internally rotate the arm as abduction is increased beyond the 90° angle, for routine purposes it would appear desirable to avoid abduction. Forward flexion of the arm is particularly undesirable, external rotation superimposing the shadows of the greater tuberosity upon the shaft, while internal rotation superimposes the shadow upon the head (Fig 5).

In carrying out roentgenologic examinations to define local portions of the humerus or scapula, the following positions are valuable. For the head, greater tuberosity, and surgical neck of the humerus, external rotation favors throwing each part into salience. Abduction is to be avoided because the shadow of the acromion overlies increasing amounts of the head as abduction occurs. For the lesser tuberosity, forward flexion of the arm (30 to 45 degrees) will aid in throwing the shadow of this portion of the humerus upward so that it can be visualized close to the superior border of the humerus, lying between the head and the greater tuberosity. This portion of the humerus may also be frequently visualized with satisfaction by external rotation of the arm combined with horizontal abduction. This position will throw the lesser tuberosity into salience along the lateral border of the upper humerus. This latter position is similar to the former in that both employ forward flexion of the arm and differ from it in that the latter combines this movement with external rotation. This is a very satisfactory position provided the arm can be placed in it and provided one remembers in making the interpretation that forward flexion of the arm tends to produce cyst-like shadows through the upper humerus. The bicipital groove is usually best visualized by external rotation, the groove being cast along the lateral border of the upper humerus. The deeper portion of the trough of the groove is visualized if horizontal adduction is employed in addition to external rotation.

The articular end of the acromion is seen through its narrowest aspect when films are

salience, an effect quite different from that obtained when the arm is held in adduction.

Postero-anterior films of the shoulder are usually not indicated since it places the scapula some distance from the film. However, one position was found to be use-

ful, presenting much the same information obtained with the arm in full abduction. This is obtained by rolling the body of the patient in the supine position in an oblique plane with the axilla applied closely to the film surface, the central ray being directed downward through the shoulder at right-angles to the film surface.

EFFECT OF ROTATION ON ROENTGENOLOGIC APPEARANCE OCCURRING DURING FLEXION AND EXTENSION OF THE ARM

The various portions of the scapula undergo very little shift in relationships until attempts at extreme flexion are employed. At moderate forward flexion (45 degrees from the frontal plane of the body), the changes are limited to the appearance of the humerus. These latter changes however, are marked, varying greatly with the degree of rotation. In the position of internal rotation (with 45 degrees of forward flexion) the plane of the epiphyseal line is approximately parallel with the film (Fig 3). The epiphyseal line, as a result, is not visualized. The articular margins of the head cast a circular shadow which is seen, superimposed upon neck and tuberosities. On the film it appears as a cyst, the articular margins of the head simulating the walls of the cyst. The superior margin of the greater tuberosity lies near the superior articular margin of the head and may even lie above it, depending upon the amount of flexion employed. It should be noted that internal rotation and forward flexion result whenever the forearm is applied to the anterior aspect of the chest and bandaged in the usual manner with a Velpeau or a Sayre bandage.

and outer clavicle upon adjacent structures the acromioclavicular joint is outlined exceptionally well. The shadows of the acromion and outer clavicle are widely separated. Both the coracoid tuberosity and the curve of the clavicle are best seen on this type of film. A low tube focus favors definition of the outer end of the clavicle, acromioclavicular joint and acromion while a high tube focus best defines the outline of the shoulder joint. A much lighter exposure is desirable for definition of the acromioclavicular joint than has been employed here. This may be accomplished by decreasing exposure factors or better, by the use of a wedge filter over this region of the film.



Fig 6 Effect of position of tube focus on roentgenologic relationships

(Upper) Tube focus four inches above shoulder joint. The superior articular margin of the head is cast entirely free from the shadow of the acromion. The outer end of the clavicle overlies the acromion with the result that the acromioclavicular joint is not well defined. The clavicle lacks its usual curve.

(Middle) Tube focus directly over the shoulder joint. A small portion of the superior articular margin of the head overlaps the acromion. The clavicle is cast at a somewhat higher level with less overlapping of acromion and clavicle. The coracoid tuberosity is partly brought into salience. The curve of clavicle is largely lost.

(Lower) Tube focus four inches below shoulder joint. While the shoulder joint is not clearly defined due to superimposed shadows of the head

If abduction of the arm is not possible, much of this same effect can be produced by employing a tube focus about four inches below the shoulder joint. This position visualizes both the outer end of the clavicle and the acromioclavicular joint quite satisfactorily. If one employs a higher tube focus, the clavicle is seen less well, and when the focus becomes above the shoulder joint level the outer end of the clavicle and the acromion process overlap one another. The articular end of the acromion commonly appears as a slender oval cyst. This position should be avoided in all cases in which an acromion or outer end of the clavicle is to be examined. A tube focus four inches medial, with the arm adducted, may be employed to visualize the glenoid and neck region of the scapula when abduction of the arm is impossible.

EFFECT OF SHIFT IN POSITION OF FOCAL SPOT IN RELATION TO SHOULDER JOINT

In shifting the tube focus four inches above the joint (Fig 6), the articular portion of the head is thrown entirely down below the acromion process so that this region of the humerus is seen with exceptional clarity. This position, however, does not show the outer end of the acromion or the acromioclavicular joint to best advantage. The outer end of the clavicle is observed overlying the acromion process. Shifting the focus of the tube four inches below the level of the shoulder joint produces marked changes in relationships of the humerus, the acromion, and the clavicle. The humerus is observed overlying a portion of the acromion. The acromioclavicular joint and outer portion of the clavicle, including its curve, is seen with great clarity if not over-exposed. When a tube focus four inches medial to the joint is used, the region about the glenoid and the neck of the scapula is seen without the presence of any confusing shadows. This throws a large portion of the scapula away from the rib cage so that its borders are usually visualized without difficulty, particularly the axillary border. Shifting the tube focus four inches lateral to the

shoulder joint does not appear to aid in visualizing any portion of the scapula, humerus, or clavicle.

FACTORS IN THE PRODUCTION OF CYST-LIKE SHADOWS

Position undoubtedly is the greatest single factor contributing to the production of confusing shadows. This study has shown that a composite motion of the arm is usually necessary before the shadows are particularly confusing (Fig 7). Internal rotation when combined with forward flexion of the arm has been found to produce these shadows with great regularity. Simple internal rotation without forward flexion, for example, is not apt to be particularly confusing, though such films are not desirable for routine radiography. Forward flexion without any internal rotation may seriously handicap the interpreter and is more apt to do so than internal rotation alone. The combination of these two movements is necessary for the production of typical cyst-like shadows. This combined movement throws the head face downward toward the film and one observes the articular margin of the head as a round cyst-like shadow. There are other factors which contribute to the production of these shadows or tend to accentuate them. These are (1) diffuse atrophy of bone and degenerative changes occurring at the articular margins of the upper humerus, (2) atrophy which leads to a washed-out appearance of the bone and tends to impart a translucent appearance to the center of the cyst-like shadow, (3) the presence of new bone formation at the articular margins which accentuates the margins of the cyst-like shadow and tends to give a true wall effect to the cyst. It should be noted that while bone atrophy and degenerative changes at the articular margins of the head accentuate the effect, these factors are impotent unless the head is thrown in a position of internal rotation and forward flexion such as results when the forearm is strapped across the front of the chest.

obtained in the usual anteroposterior position, but its broader dimensions may be obtained by abducting and externally rotating the arm. The base of the acromion is better visualized without abduction. As the extent of abduction increases the base of the acromion and the scapular spine run in a nearly straight line as a broad band of density. The coracoid process is very poorly visualized in the usual anteroposterior film of the shoulder, but can be brought into salience by abduction and external rotation of the arm. In complete abduction, the tip of the coracoid process often overlies the outer end of the clavicle. At 135 degrees of abduction, the coracoid process is usually visualized above the level of the superior border of the scapula and beneath the clavicle, and is seen with great clarity in this position. If the shoulder is taken at 90 degrees of abduction, external rotation materially aids in throwing the

coracoid process into salience. The glenoid and the neck of the scapula are usually best brought into salience if pain does not prevent the use of the position by extreme abduction, elevating the arm away from the side of the body as much as possible. This also outlines the superior border and the axillary border of the scapula to great advantage, the use of this position permitting the visualization of the axillary border, and the lateral portions of the scapula, including the glenoid, are entirely free of lung structures. The outer end of the clavicle is often poorly visualized in the usual anteroposterior films of the shoulder. The curve is commonly lacking and the clavicle imparts a straight appearance which is entirely erroneous. The normal sweep of the outer end of the clavicle is observed without difficulty if the individual is able to abduct the arm above the head and externally rotate the arm as much as possible.

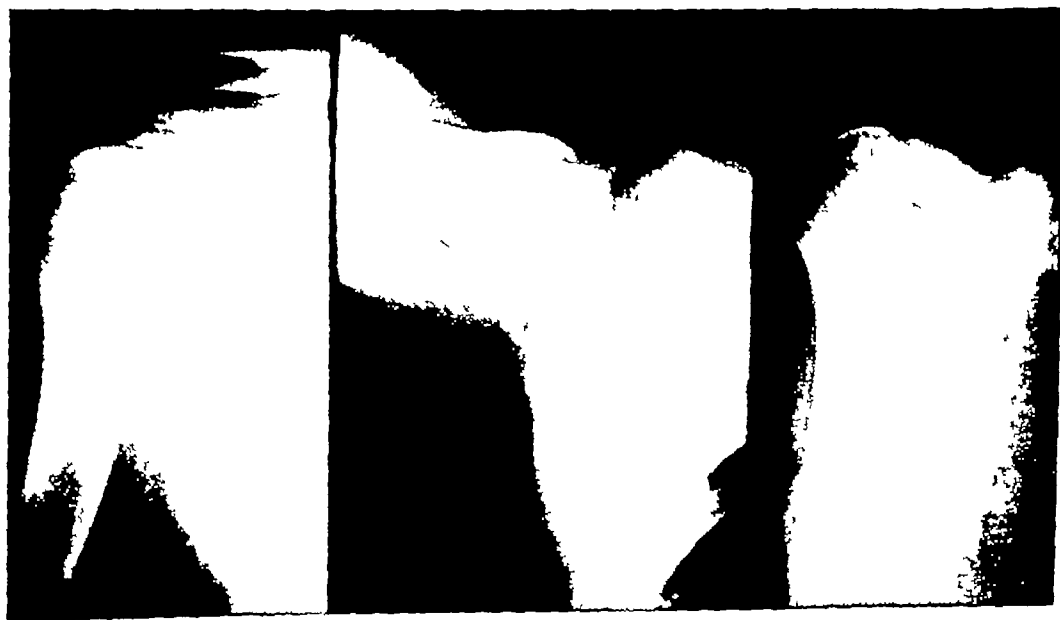


Fig 7 Effects of internal rotation forward flexion and the two movements combined
 (Left) Extreme internal rotation without forward flexion. The articular convexity is sharply outlined directed upward and slightly away from the scapula. The plane of the epiphyseal line can be identified. Note the absence of cyst-like shadows.
 (Middle) Forward flexion (45°) without internal rotation. The epiphyseal line is lost. While a definite wall cystoid shadow is not identified there is a tendency for the upper humerus to appear vacuolated.
 (Right) Forward flexion (45°) and internal rotation (90°). The margins of upper humerus outline a cyst-like shadow. The inferior border of this shadow is due to lower articular margin of the head its circular contour being distorted by the superimposed shadows of the outward flaring of the cortex of the greater tuberosity. Internal rotation and forward flexion alone are incapable of producing the typical shadow of a cyst, while the combined movement will produce such a shadow with great regularity.

THE GASTRO-INTESTINAL TRACT IN CHILDREN¹

By JOHN S BOUSLOG, A B , M D , *Denver, Colorado*

IN studying the roentgenologic examination of the intestinal tract of adults we are often confronted with various problems which are very difficult to explain. Dr Cunningham, Dr Walton, Dr Hanner, Dr Waltz, and I studied the

In the investigations of the gastro-intestinal tract it seems desirable that efforts should proceed along the line of adapting the technic more closely to the normal functioning of the alimentary tract. In this way the physiology as well



Fig 1-A Stillbirth No air in lungs or gastro intestinal tract (Left)
Fig 1-B Two hours after normal birth Air is in stomach and small intestines
on left side (Right)

intestinal tract of infants in an attempt to arrive at a better understanding of the normal and pathologic gastro-intestinal conditions in adults. These infants were studied from the age of ten days to four months. I shall not take your time to give any technical procedure as this has been published, except to state that we studied these children under their normal environments and routine at the Crittendon Home in Denver.

as the anatomy of these structures can be studied and the beginning of disease can be determined by the early pathologic changes.

An opaque meal may soon be devised which is less artificial and unpalatable than any we are now using. The recent introduction of the meal in a more dilute form so as to demonstrate the rugæ of the stomach and to show more clearly the peristaltic action is a good indication of what may be done. Dr Pendergrass in his work has shown the effects of different meals and drugs on the reaction of the intestinal emptying time and in the intestinal pattern.

¹ Read before the Midsummer Radiological Conference in the Rocky Mountains Aug 5 6 and 7 1936 Denver, Colorado. Sponsored by The Denver Radiological Club.

SUMMARY AND CONCLUSIONS

1 The effect of movement of the shoulder joint upon the changing anatomic relationships has been correlated with the radiographic appearances produced as a result of such movement

2 For routine radiography of the shoulder, the placing of the arm in the anatomic position with the palm of the hand forward in the supinated position is recommended whenever external rotation can be employed, because this position defines the body structures at the shoulder with great clarity except for the lesser tuberosity of the humerus, and at the same time avoids the possibility of the production of confusing shadows

3 For the lesser tuberosity and portions of the scapula and outer clavicle, several positions have been described which will greatly enhance the amount of infor-

mation to be gained by radiography if the position proves to be one which can be assumed by the patient

4. Internal rotation and forward flexion of the arm are to be avoided in radiography of the shoulder. These movements of the arm favor the production of confusing shadows in the upper end of the humerus and offer a further disadvantage in that the head and neck as well as the tuberosity are not clearly defined

5. A tube focus four inches above the shoulder joint favors better definition of this joint, while one four inches below the shoulder joint enhances the definition at the acromioclavicular level

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a part of the gastro-intestinal contents. This raises the question as to the possibility of air being the first stimulant to

The stomach as it fills with the meal moves outward toward the anterior abdominal wall, slightly downward, and to the

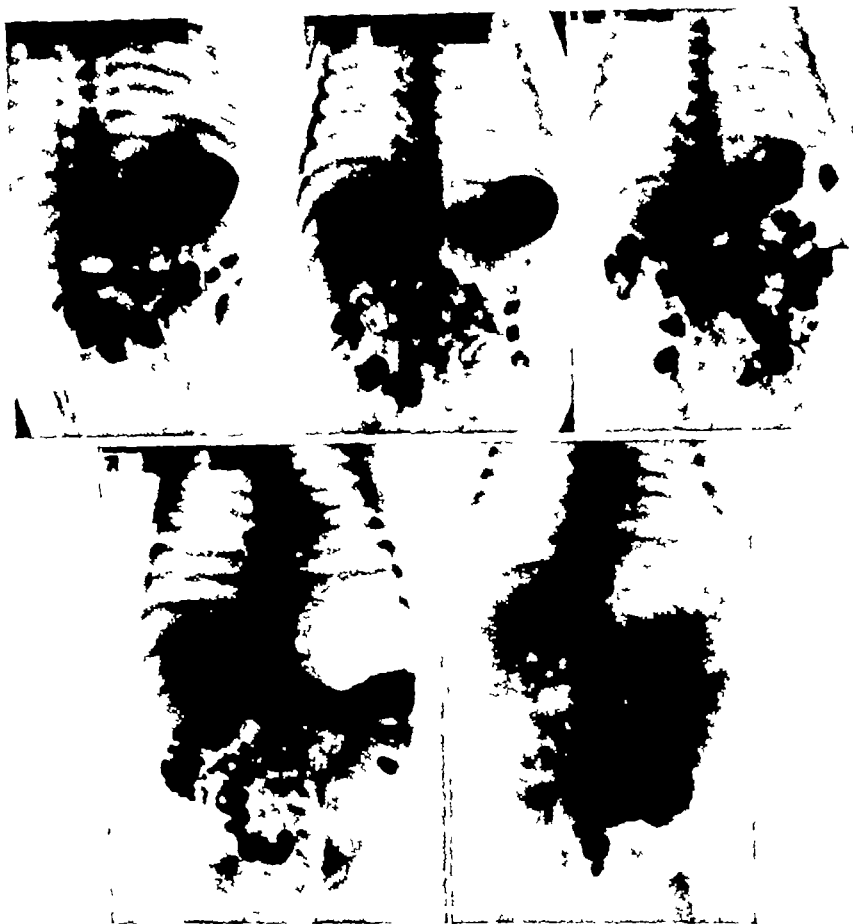


Fig 2-C Two-hour film, small intestinal pattern different from adult (*Upper left, two views*)
 Fig 2-D Four hour film meal progressing rapidly through intestines (*Upper right*)
 Fig 2-E Eight hour film, meal practically all in colon (*Lower left*)
 Fig 2-F Twenty eight hour film, small residue in lower left colon (*Lower right*)

enter the gastro-intestinal tract, and it may be a large factor in starting the first desire to nurse.

The infant stomach assumes a transverse position, is high in the abdomen, and to date, not a single low stomach has been noted in a normal child under nine months of age. The lower border of the greater curvature is usually above the level of the third lumbar vertebra. It takes various shapes, depending upon the age of the infant. The most usual shapes are the following pear-shape, ovoid, occasionally steer-horn. The shape of the stomach varies in different examinations

right, completely obscuring the pylorus and duodenum in the postero-anterior view. The meal starts leaving the stomach immediately. There is seldom any evidence of a peristaltic wave in the normal infant stomach under three months of age. Apparently the stomach contracts gradually in its entirety as it seems to shrink in size in all diameters as the contents enter the small intestines. This finding has not been conclusively established and is still being investigated. Only occasionally is a peristaltic wave observed on the roentgenogram.

As the stomach empties it tends to form

In order to obtain as much knowledge as possible a few x-rays were taken of infants after normal birth and before a single

studies were performed at St Anthony's Hospital. The procedure revealed the fact, observed by Dr Wasson and myself,



Fig 1 C Same child as shown in Figure 1 B, six hours after birth air is continuing through the intestines (Left)

Fig 1-D Same child as shown in Figure 1-B, twenty four hours after birth intestinal tract filled with air (Right)



Fig 2 A Child aged eleven days Postero-anterior view stomach is high and in transverse position, duodenum not showing (Left)

Fig 2 B Ten minutes later, oblique view showing duodenum (Right)

breath had been taken, then a second x-ray immediately after the first breath, followed by others at five minutes, ten minutes, and at twenty-four hours. These

that air enters the stomach with the first breath and with subsequent breathing continues on through the intestinal tract. From then until after death, air makes up

o the distention of the stomach, and is very movable in the transverse and antero-posterior direction. It is not higher than

the lesser curvature of the stomach and usually it is lower.

The duodenum is of special interest as

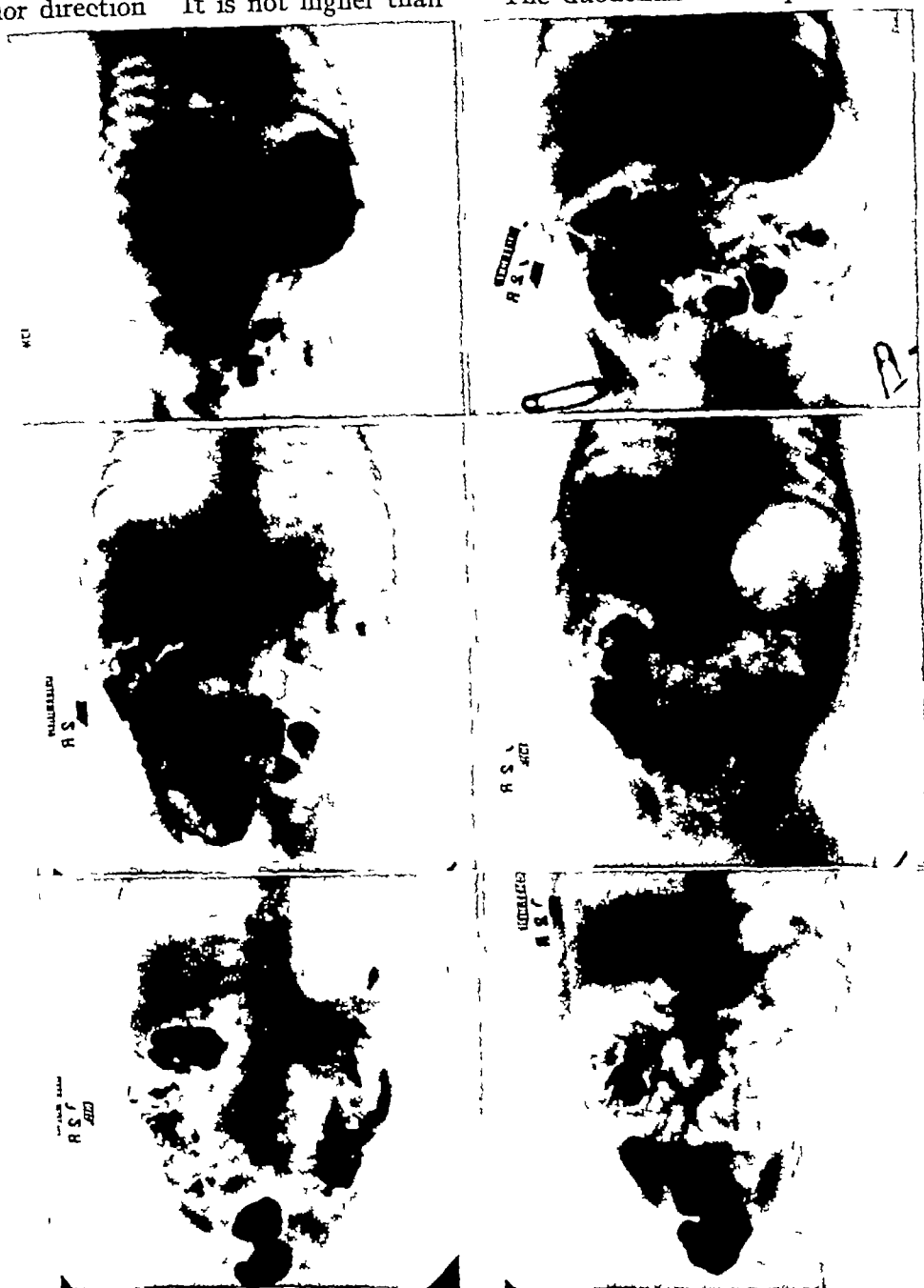


Fig 4-A Child aged five months, fifteen minute film, oblique view. Stomach high, duodenum only slightly visualized. (*Upper left*)

Fig 4-B One and one half-hour film. Stomach has changed shape and duodenum visualized on level with lower part of stomach. (*Upper right*)

Fig 4-C Six-hour film, stomach practically empty, intestinal pattern different from adult. (*Middle left*)

Fig 4-D Nine hour film. Stomach empty, meal practically all in colon. (*Middle right*)

Fig 4-E Twelve hour film, meal all in colon. (*Lower left*)

Fig 4-F Twenty four hour film, small amount of meal remaining in rectum. (*Lower right*)

a large tube. Often at this stage the pylorus and duodenum are seen stretching to the right on about the same level with the stomach proper. The pylorus is not clear-cut and is just noted at the end of the stomach. Its position varies, according

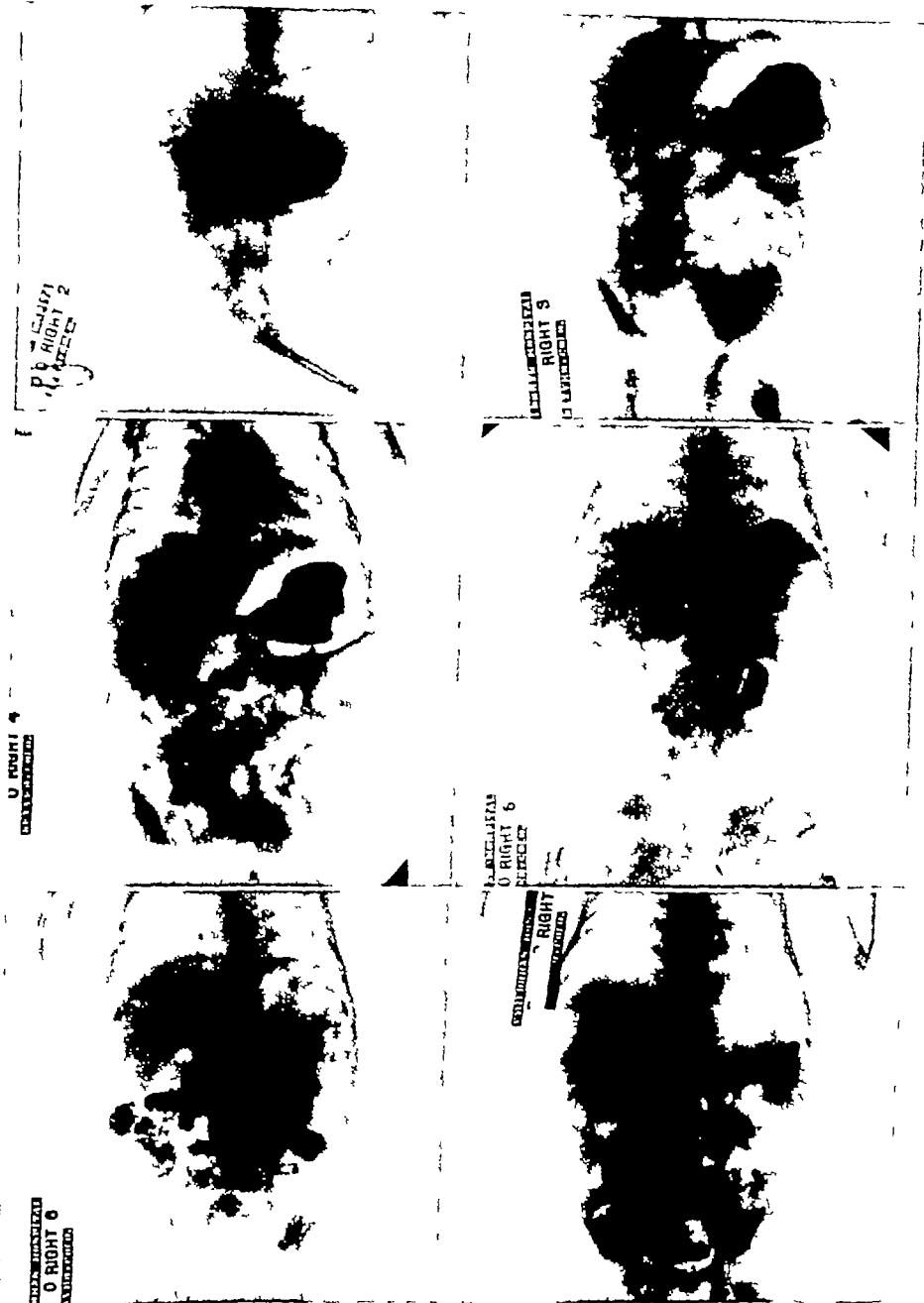


Fig 3-A Child aged two months. Postero-anterior view of stomach in transverse position (Upper left)

Fig 3-B Twenty minutes later oblique view showing duodenum in horizontal position. (Upper right)

Fig 3-C One-hour film duodenum appears as tube (Middle left)

Fig 3-D Three-hour film, stomach contracting in its entirety (Middle right)

Fig 3-E Six hour film stomach empty, no definite intestinal pattern (Lower left)

Fig 3-F Twenty four hour film very small residue in cecal region (Lower right)

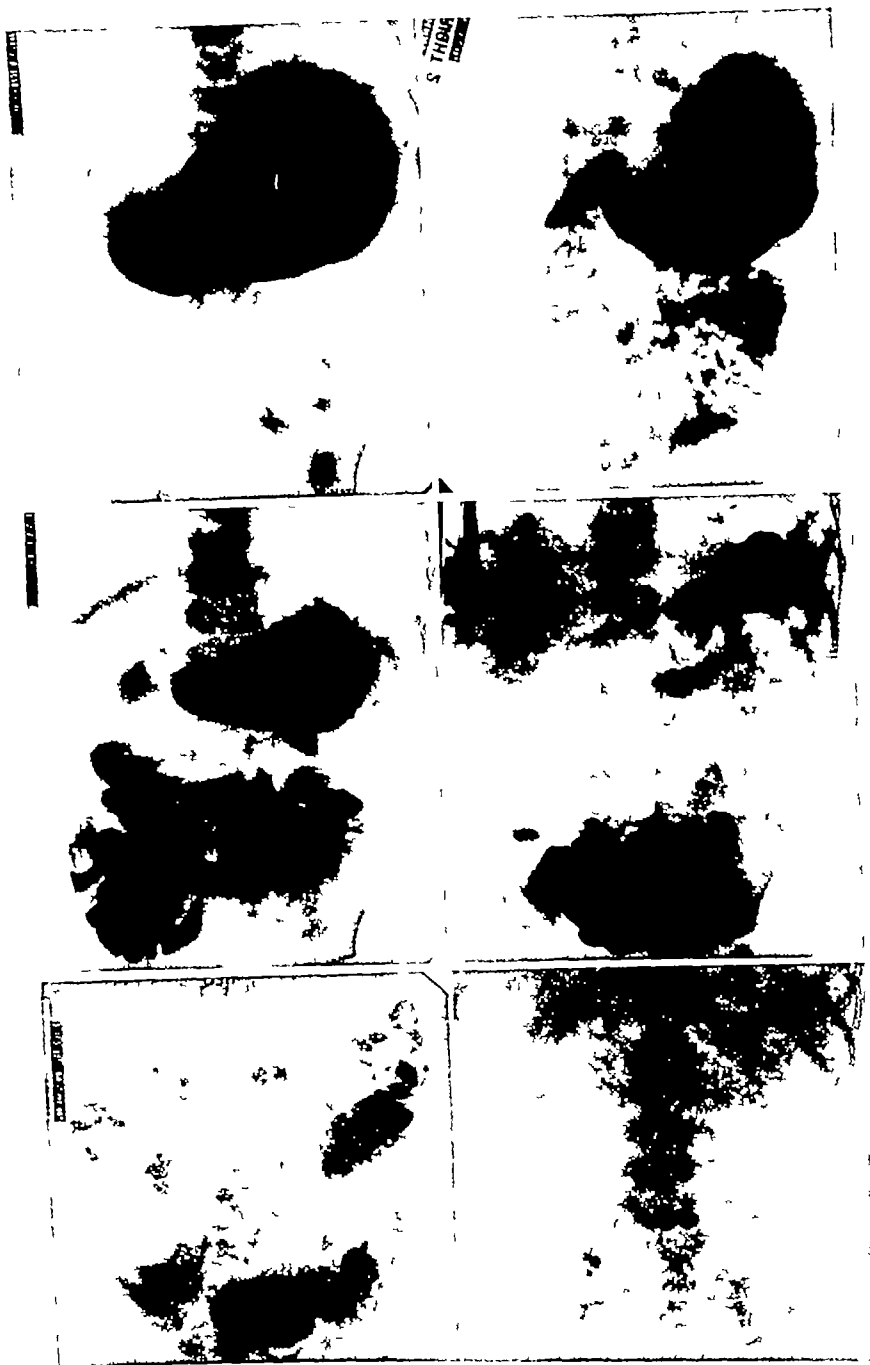


Fig 6 A Child aged nineteen months Stomach high in abdomen (*Upper left*)

Fig 6-B Fifteen minute film, oblique view showing duodenum and stomach changing to adult type (*Upper right*)

Fig 6-C One-hour film intestinal pattern beginning to change to adult type (*Middle left*)

Fig 6-D Four hour film, intestinal pattern in ileum changing to adult type (*Middle right*)

Fig 6 E Twenty four-hour film, showing more stasis of colon than in young infant (*Lower left*)

Fig 6-F Forty-eight hour film, colon completely empty (*Lower right*)

the first portion is behind the pyloric end of the full stomach and cannot be seen in an x-ray taken from the direct postero-

When the second and third portions are visualized they are practically the same as the first portion

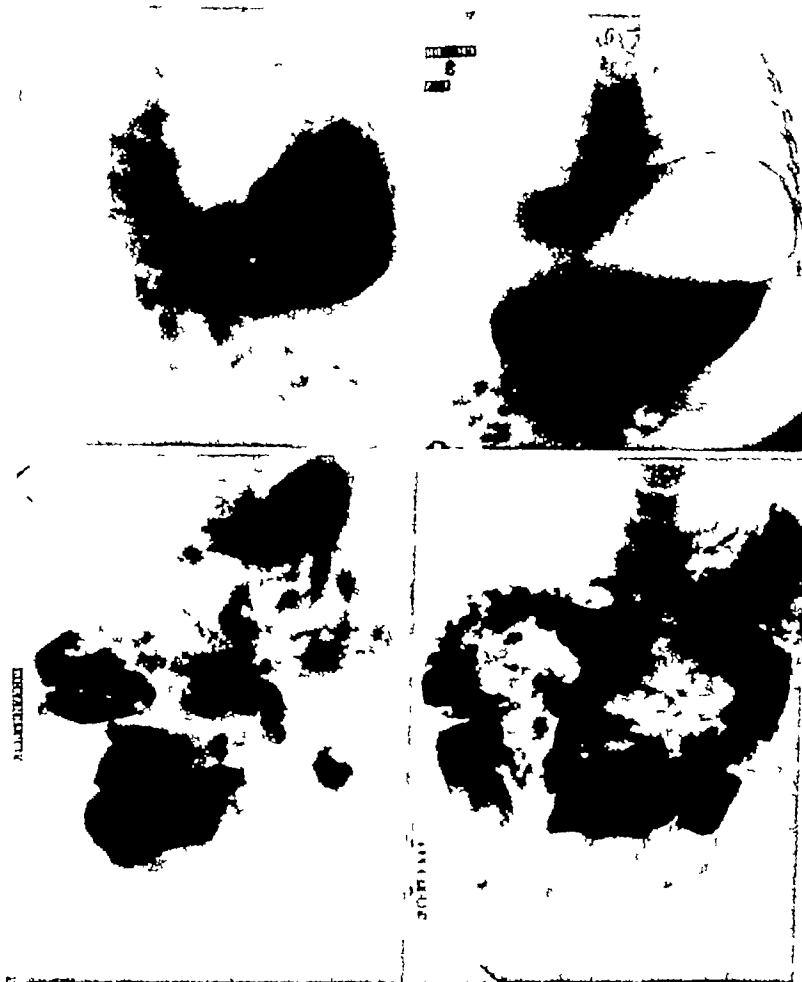


Fig 5-A Child aged one year oblique view Stomach high in abdomen (Upper left)

Fig 5-B Same child erect position Stomach does not swing down as in adult (Upper right)

Fig 5-C Four hour film, intestinal pattern beginning to change to adult type (Lower left)

Fig 5-D Six hour film stomach practically empty, meal filling colon to splenic flexure colon was empty in twenty four hours (Lower right)

anterior view The infant must be rotated well to the right—to about a 60° angle The usual triangular cap is rarely seen, the first portion of the duodenum fills in a horizontal position as a more or less short straight tube and, as a rule, in the first few months, lies at the level of the first lumbar vertebra The second and third portions are seldom visualized, apparently due to the rapid emptying time

In the jejunum and ileum the meal is apparently segmented and grouped The segments usually have oblong shape with not much form These segments are found grouped in various sections of the abdomen as the meal progresses The usual feathery appearance (sometimes spoken of as "snow flake appearance") of the jejunum, seen in the adult, is not observed in infants

smaller in children than in the adult

The variations in the anatomy mentioned in regard to mucosa, submucosa, and muscularis probably account for the statement made earlier in this paper, to the effect that the meal is segmented and grouped in the jejunum and ileum in the infants studied

The small intestine bears the principal work of digestion and absorption of food. The digestion of the food is accomplished by two main types of intestinal motility: the peristaltic and pendulum motions. The peristaltic motions serve to propel the injected food onward through the intestinal canal, while the pendulum motion serves to mix the food with the intestinal juices. The pendulum motion originates by co-ordination of the annular and longitudinal musculature by which the contraction of the longitudinal musculature of the intestine is shortened and broadened, and the contraction of the annular musculature is constricted. Thus these motions cause the food to be digested and continually permit the food to come in contact with new surfaces of the small intestinal mucosa for absorption.

The exceedingly lively peristalsis of the small intestine is significant for the duration of the intestinal passage in the young infant. The meal is often at the cecum in one and one-half hours and the small intestine is empty in five hours unless the stomach is slow in emptying, while in the adult the time is usually about three hours to reach the cecum and from eight to ten hours to empty.

The digestive activity of the large intestine plays only a subordinate rôle in comparison with that of the small intestine. It is here that we see many of our problems in the adult. The stagnation and exclusion of the ingested food and the resorption of the water thus causes a thickening of the intestinal contents.

The waves of the large intestine correspond essentially to those of the small intestines. Here also are found the peristaltic and pendulum motions, which have the same function as in the small intes-

tines. Von Bergmann and Katsch showed that the haustra are not anatomic preformation structures, but in the changeful play of motion, they exercise the functions of mixing, kneading, and pendulum action, which in the polymorphic haustration find a multiform expression in the roentgenogram. The haustra are said to be absent in the newborn, but they appear in the first months of post-natal life. This is not true, as they are present in our series on our first examinations, namely, in babies of from ten to fourteen days old. They are not as pronounced as in the adult, but one would not expect to find them so, due to the difference in the development of the mucosa, submucosa, and muscularis, as described above.

The cecum in the infant is in approximately the same topographical relation as in the adult. I have already mentioned the position of the transverse and descending colon. I wish to repeat that as a rule the colon is empty in these babies in twenty-four hours, which is not the case in the adult. If there is any residue in the colon at twenty-four hours, it is usually only in the sigmoid and rectum. Therefore, it is possible that the constipation seen in adults may be the result of the stagnation of the lower part of the colon, beginning in infancy. Infants have an average of two stools per day, while in adults the average is only one. That one stool does not empty the colon is proved by the barium meal remaining in the colon usually for thirty-six hours or longer, depending upon the amount of constipation.

If one studies the adults who have two evacuations per day he finds that they do not have the toxic conditions seen in patients with constipation. In comparison, babies require more nourishment than adults, but they do not have the stagnation of the colon. Thus it follows that absorption from the intestines must take place more energetically in early childhood than in the adult life.

In discussing the gastro-intestinal x-rays of infants and young children, their exact age must always be taken into account, as

When the meal reaches the cecum there is not the delay which is quite customary in the adult. It moves rapidly on toward the rectum. The position of the colon is not unlike that in the adult except that the

owe our first roentgen observation of the intestinal motions in animal and man.

The structure of the intestinal tract in infancy and childhood is different from that of the adult. Many observers have



Fig 7-A Child aged six weeks, appendix showing cecum empty (Left)
Fig 7-B Same child checking to show cecum filled appendix is retrocecal (Right)

transverse colon is not low and assumes a fairly straight line across the abdomen, usually crossing at the level of the first or second lumbar vertebra, but this depends on the state of dilatation of the stomach by gas. The hepatic and splenic flexures are as a rule gradual curves, but they seem well fixed. The peristaltic waves apparently move the contents with ease and although the meal is often cut into widely separated segments, the haustra are not acute or pronounced. As a rule the barium meal has entirely left the gastrointestinal tract in twenty-four hours. Occasionally a few areas of opaque residue are left in the sigmoid and rectum.

The roentgen examination permits study of the motor function of the intestines and the progressive action of their contents under physiologic conditions in a continuous manner. It is to Cannon that we

noticed the thin, paper-like consistency of the intestinal wall. Examined, it reveals the following:

(a) The mucous folds and the valvulae conniventes are more abundant in childhood, but their lengths and heights are distinctly smaller than in the adult.

(b) The mucous membrane is absolutely and relatively more developed than the muscular layer, it is very delicate and vascular, and more cellular as compared with the adult.

(c) The submucous tissue is less in quantity and more delicate in character. The elastic fibers are feebly developed—a fact which explains the greater vulnerability of the infant's intestines as compared with those of the adult. The muscularis shows a thickness equal to both the mucosa and submucosa.

(d) The size of the villi and follicles is

smaller in children than in the adult

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The waves of the large intestine correspond essentially to those of the small intestines. Here also are found the peristaltic and pendulum motions, which have the same function as in the small intes-

tines. Von Bergmann and Katsch showed that the haustra are not anatomic preformation structures, but in the changeful play of motion, they exercise the functions of mixing, kneading, and pendulum action, which in the polymorphic haustration find a multiform expression in the roentgenogram. The haustra are said to be absent in the newborn, but they appear in the first months of post-natal life. This is not true, as they are present in our series on our first examinations, namely, in babies of from ten to fourteen days old. They are not as pronounced as in the adult, but one would not expect to find them so, due to the difference in the development of the mucosa, submucosa, and muscularis, as described above.

The cecum in the infant is in approximately the same topographical relation as in the adult. I have already mentioned the position of the transverse and descending colon. I wish to repeat that as a rule the colon is empty in these babies in twenty-four hours, which is not the case in the adult. If there is any residue in the colon at twenty-four hours, it is usually only in the sigmoid and rectum. Therefore, it is possible that the constipation seen in adults may be the result of the stagnation of the lower part of the colon, beginning in infancy. Infants have an average of two stools per day, while in adults the average is only one. That one stool does not empty the colon is proved by the barium meal remaining in the colon usually for thirty-six hours or longer, depending upon the amount of constipation.

If one studies the adults who have two evacuations per day he finds that they do not have the toxic conditions seen in patients with constipation. In comparison, babies require more nourishment than adults, but they do not have the stagnation of the colon. Thus it follows that absorption from the intestines must take place more energetically in early childhood than in the adult life.

In discussing the gastro-intestinal x-rays of infants and young children, their exact age must always be taken into account, as

apparently the position of the organs and their functions are undergoing continuous change. There is apparently a progression of form and function which takes place from birth until death.

In conclusion, I wish to state that the gastro-intestinal tract of infants presents many different aspects from that of the adult. I have not attempted to form any definite conclusions, as many problems requiring further study have presented themselves and are at present unsolved. I find it is necessary to establish more definite standards of the physiology of the gastro-intestinal tract in the first few weeks of life.

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A METHOD FOR DECREASING THE IONIZATION IN THE SKIN APPLICABLE TO SUPERVOLTAGE X-RAY THERAPY

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IN the "Béclère Festschrift für Strahlentherapie" (1) one of us pointed out a new possibility in radiation therapy with supervoltage x-rays. In the present paper will be given some corroborating experimental data obtained with gamma rays, in the absence of x-rays produced at potentials above one million volts.

So far as we are aware at present, all biological and therapeutic effects brought about by x-rays and gamma rays from radium are the result of ionization taking place in the tissues of the test object or in those of the patient. In the treatment of patients part of this ionization is desirable and part harmful, *i.e.*, the ionization occurring in the tumor destroys the cells of the tumor and tends to bring about the result sought after, whereas that occurring in the skin or the normal tissues between the skin and the tumor results in unfavorable reactions such as erythema, epithelitis, ulceration, etc. The limiting factor in the amount of ionization with consequent cell destruction which can be brought about in the tumor is the amount of concurrent damage which can be safely tolerated by the skin and normal tissues between the skin and tumor. If it were possible to reduce materially this ionization without lowering the dose received by the tumor, either one of two results of practical importance might be brought about: the treatment of tumors by external irradiation in dosages now found to be therapeutically effective without the severe reactions seen in the skin, or an increase in tumor dose without increasing damage to the skin.

Electromagnetic radiation of therapeutic wave lengths such as occur in beams from x-rays tubes and radium probably bring about reactions through the formation of secondary electrons, high speed negatively charged particles, which in turn separate

electrons from atoms in the material irradiated. It is this ionization brought about by secondary electrons in air which allows us to measure the intensity of x-ray and gamma-ray beams. In radiation therapy part of the ionization occurring in the superficial layers of the skin is the result of secondary electrons produced in the air and any other intervening matter between the radiant source and the skin. The rest is due to electrons liberated in the skin itself.

Not all of such electrons have the same speed or length, of course. The speed of the electron and hence the distance it will go either in air or through the skin depends on the amount of energy imparted to it. For instance, the farthest distance a secondary photo-electron generated by 200 kv x-rays can go in air at standard conditions of temperature and pressure is about 32 cm, whereas the corresponding distance at 1,000 kv is in the vicinity of ten times this distance, or 340 cm (1). This does not mean that all secondary electrons will go such a distance but only an occasional photo-electron, one having the maximum amount of energy. However, it does make it evident that beta particles from different x-ray sources will be capable of different degrees of penetration through the skin, the maximum depth of penetration depending on the generating voltage. Skin is roughly eight hundred times as dense as air, so that, allowing for the difference in density, the *most* penetrating electrons from a 200 kv source could go only 0.4 mm into the skin. Remembering that this distance can be reached only by the very rare photo-electron, generated in the air just above the skin, whose course is straight downward and that the vast majority of secondary electrons have much shorter paths, it becomes apparent that the ionization produced by the secondary electrons generated

in the air or matter between an ordinary x-ray tube and the patient's skin is confined to the very superficial layers of the skin. The effective secondary electrons, of course, are the ones generated in the skin and subcutaneous tissues themselves.

If we consider the beam from a 1,000 kv x-ray generator however, the picture is quite a different one. The farthest course of a photo-electron in air at such a voltage has been given above as 340 cm. It is then theoretically possible for such an electron to penetrate somewhere in the neighborhood of 42 mm of skin or tissue, a depth which is much below the horny dead layers and even well below the dermis itself over most areas of the body. This, again, is a maximum distance, but nevertheless the average penetration of the secondary electrons produced by 1,000 kv x-rays is correspondingly high.

Secondary electrons have two properties which make them fairly easy to remove from a beam of radiation: first, they are negatively charged particles in motion, and in consequence, will be deflected in a magnetic field, and, secondly, they do not travel in straight lines in air but have irregular zigzag courses as a result of atomic collisions. This irregularity of path makes it possible to remove them by sending the beam of radiation through a series of diaphragms or a long narrow channel. A simple experiment brings out this point very strikingly. In Figure 1 is a thin-walled glass tube containing radon, which serves as a source of high speed beta rays (and, unavoidably, gamma rays). At a distance of 62 cm from the source is placed an ionization chamber made of thin paper with a "front wall" of silk netting. Under these conditions the ionization current produced in the chamber may be taken to be 100 units for purposes of comparison. The same beta-ray source placed in a lead cone as shown in the upper part of the figure, with the ionization chamber properly aligned and again at a distance of 62 cm, produces a current of only 4.8 units. The marked decrease in the ionization current shows that most beta particles which originally reached

the chamber, either have been entrapped by the lead canal or have wandered out of the narrow cone subtended by the chamber. Of course, if beta rays travelled in straight lines originating at the source, there could have been no such decrease in current, since, as shown in the figure, the ionization chamber is well within the geometric projection of the lead cone. The "removal" of the beta rays from the straight line beam reaching the chamber is even more effective than indicated by the above figures, because of the presence of the gamma rays. After placing a strong electromagnet at the mouth of the lead cone to deflect the emergent beta rays, the residual ionization reading due to the gamma rays is found to be 2.07 units. Making allowance for this we find that the ionization in the chamber due to the primary beta rays alone, drops to 2.8 per cent when the source is placed in the lead cone. Although this is an extreme case, it indicates, nevertheless, the great efficacy of the simple canalization method in removing secondary electrons from a narrow beam of extremely hard x-rays, especially when one considers that most of the secondary electrons in such a case would come from the filter, irrespective of the material of which it is made.

If we remove the secondary electrons from a beam of x-rays or gamma rays and direct the beam at the skin, the resulting effect will depend on two factors: first, the depth at which erythema, epithelitis, or ulceration takes place, and, second, how much of a reduction in ionization can be obtained at that depth by removal of the secondary electrons in the air above the skin. Is it possible to remove a sufficiently large proportion of high speed beta particles from any therapeutic gamma or x-ray beam so that a significant difference in ionization will occur in the skin at the depth at which erythema takes place? As already mentioned, such a reduction in ionization may be expected to be of practical importance only in beams the generating voltages of which are of the order of one million volts.

Erythema is an effect taking place in the

skin and not in the subcutaneous tissues. As partial evidence for this may be mentioned the sharpness of the edge of the erythema from a well defined beam of 200 kv x-rays, a sharpness which would not be ex-

pected if the erythema were due to changes in the deep arteries or arterioles. The erythema is uniform, a result one would expect only with uniform capillary dilatation and not from arteriolar change. Czunft and Gaal (3) have studied biopsy specimens from skin showing acute radiation erythema and found the most marked changes to be a thinning of the epithelium, a destruction of the cells of the stratum spinosum, and a hypertrophy of the papillae of the cutis. Assuming that the changes causing erythema do occur in the skin, the depth at which they take place is immediately limited to its thickness. Laurens (4) gives as the thickness of the epidermis over the papillae on the forehead 0.06-0.09 mm, on the cheek 0.06-0.1 mm, and on the neck, arm, abdomen, back, and leg 0.04-0.15 mm. Between the papillae it is slightly thicker. The dermis is 1.7-2.4 mm thick. Assuming that the erythema takes place as a result of damage to the deepest layers of the dermis or corium, this layer would not be more than three millimeters below the surface and in most parts

of the body two millimeters or less. The changes causing erythema probably occur more superficially than this.

The erythema caused by irradiation with radium and x-rays is similar in so many re-

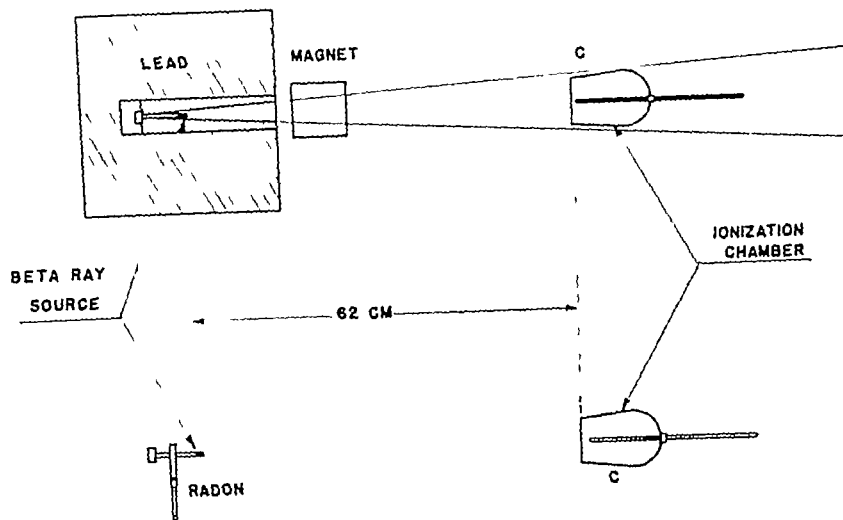


Fig 1 Effect of canalization of beta rays on ionization at a distance from source

spects to that caused by ultra-violet light that it may be justifiable to reason by analogy from observations made on the latter. Hasselbach (5), in 1911, using the Kromayer water-cooled quartz mercury vapor lamp, determined spectrographically the transmission of certain wave lengths by human skin. He found no transmission through 1 mm of skin of wave lengths at or below 3,020 Å U and only 0.006 per cent at 3,130 Å U. These wave lengths are the ones in sunlight responsible for sunburn. 0.1 mm of skin transmitted 30 per cent at 3,130 Å U, 8 per cent at 3,020 Å U, 2 per cent at 2,970 Å U, and 0.01 per cent at 2,890 Å U.

These results were questioned by Macht and Anderson (5), who found transmission of ultra-violet light of wave length 2,800 Å U through the living abdominal skin of rabbits 1 to 2 mm thick. Rays of 3,000 Å U were transmitted through the whole thickness of the abdominal wall of rabbits, 3 to 4 mm. They thought that Hasselbach's results came from using dead skin which was more opaque than living skin.

Bachem and Reed (7) have done extensive experiments on this problem and fail to confirm Macht and Anderson. They investigated both living and dead skin from dogs and rabbits, finding no change in opacity so long as it was kept stretched and moistened with Ringer's solution. Drying increased rather than decreased the transparency to ultra-violet.

Bachem (8) has carefully studied the transmission of ultra-violet light by the various layers of the human skin using frozen sections of fresh tissue. His results, as summarized in a table, show an absorption of from 66 to 85 per cent of the ultra-violet rays occurring in sunlight and known to be responsible for erythema in the stratum, the thickness of which he gives as 0.03 mm. The stratum granulosum and germinativum at a depth of 0.05 mm absorbs from 6 to 18 per cent of these wave lengths, while the remaining 9 to 16 per cent is completely absorbed in the corium at a depth of 2 mm or less. He believes erythema to occur in the stratum germinativum or upper layers of the corium.

The tanning following ultra-violet erythema occurs in the germinativum and granulosum at a depth of from 0.04 mm to 0.2 mm. Lewis (9) believes the erythema following radiation of any wave length which produces it, ultra-violet or gamma ray, to be due to the liberation of a histamine-like substance in the deeper layers of the epithelium or the superficial layers of the corium which slowly diffuses into the capillaries, causing their dilatation. This view has been further elaborated and the histamine-like substances isolated by Ellinger (10). Ellinger in his monograph on the biological foundations of radiation therapy mentions that by means of the Schulze-Winkler oxidase reaction the depth of penetration of ultra-violet light can be determined. The light destroys the oxidase in the cells upon which it falls, leaving them colorless to a depth of 0.63 mm.

Thus the answer to the question at what depth does the erythema reaction occur in the case of gamma rays is that presumably it occurs within, at most, 2.5 mm of the

skin surface and probably within 1 mm. If this is so, any method whereby we can reduce the ionization occurring within 2 mm of the surface ought to reduce the erythema produced or allow a larger dose to be given without further skin damage. Assuming that the ionization can be reduced in these superficial layers and that erythema will not occur with the doses now used therapeutically, no more damage will occur in the subcutaneous tissue than we see at present. But with higher dosages the limiting factor may become the tolerance of the subcutaneous tissues. No experimental work has been done on this question and a discussion of such effects would be in the realm of pure speculation. Nevertheless, one should bear this in mind.

The answer to the second question, "How much can we reduce the ionization at these depths by removing secondary electrons from the incident beam?" is the subject of our present experiments. In order to obtain a beam containing very high speed secondary electrons, we have used radium or radon as our source. In practical therapy the method would be more applicable to supervoltage x-rays than to gamma rays, because of the mechanical difficulties in working at such short distances as are necessary with the usual amounts of radium in packs or bombs.

As was stated above, it should be possible to remove many secondary electrons from a beam simply by canalizing it. Such experiments were carried out under rather unfavorable conditions with the four-gram radium element pack. The method was to measure the ionization produced by the radiation as different methods of controlling the electrons were investigated. The construction of the ionization chamber, of the parallel plate type, is indicated in Figure 2. The upper (charged) electrode is made of fine silk netting, so that electrons can pass freely through its interstices and ionize the air between it and the lower electrode. The latter is a drum skin (parchment) stretched tightly and fastened to a block of paraffin, as shown. The desired electrical conductivity of both electrodes

was obtained by painting with India ink. The collecting electrode is a circle 3 cm in diameter separated from the rest of the skin by an air space of 2 mm, and connected to the current measuring instrument by a

beyond the mouth of the pack. One of them had a converging, and one a cylindrical channel, shown to scale in the figure. Other types were also tested, the data for these two are, however, typical

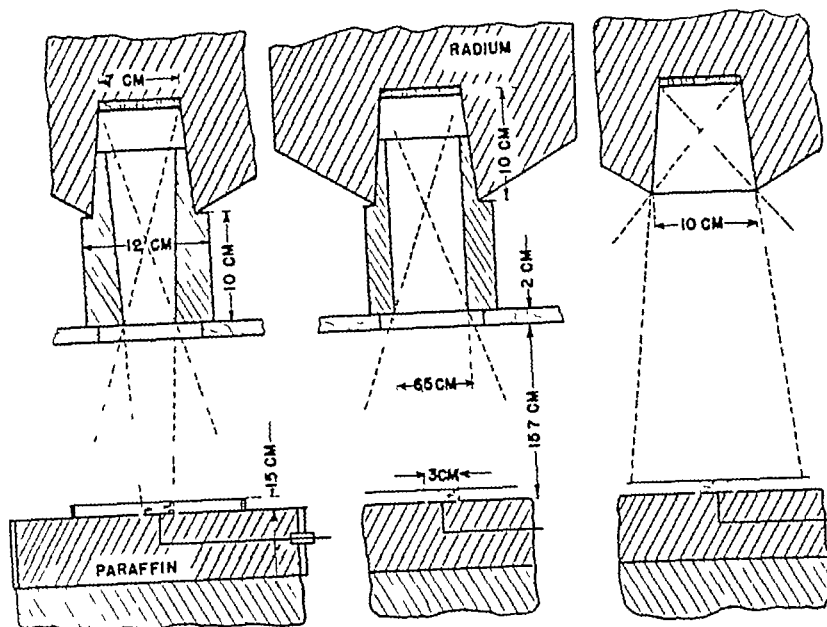


Fig 2 Experimental conditions with canalized gamma rays

fine aluminum wire embedded in the paraffin backing. The skin surrounding the collecting electrode serves as a guard ring and is connected to ground.

When a beam of gamma rays falls upon the chamber, as shown in the diagram, ionization occurs which is comparable to that at the surface of the human body. It is produced by the secondary electrons coming from the filters in front of the radium, from the walls of the collimator, from the air, and also from the underlying parchment attached to the paraffin block. This last group are a part of the back-scatter, and correspond to that which the surface of the skin receives from underlying tissues.

In Figure 2 are shown three schematic diagrams of the four-gram radium pack(11) as used in the experiments. In two of them lead collimators have been fitted to the mouth of the aperture. They were 12 cm in outside diameter and projected 10 cm

A direct comparison of the ionization readings with and without the lead collimators in place is not permissible, since the latter change the size of the gamma-ray beam. However, the effect of the canalization on the electron content of the beam may be ascertained in another way. If a thin sheet of cellophane be placed on top of the upper electrode it will absorb some of the slow electrons from the beam, but will itself contribute some, which will enter the chamber. If it contributes more than it removes, the reading with it will be greater than the one without it. Successive layers may be added until one produces no further increase, that is, until the electrons added just compensate for those absorbed. Further layers of material will only decrease the reading. In a beam from which many electrons have been removed, it will be necessary to interpose an appreciable thickness of organic material before the

maximum reading is obtained, that is, before there are as many secondary electrons as there would have been in the original gamma-ray beam, in equilibrium with its secondary electrons

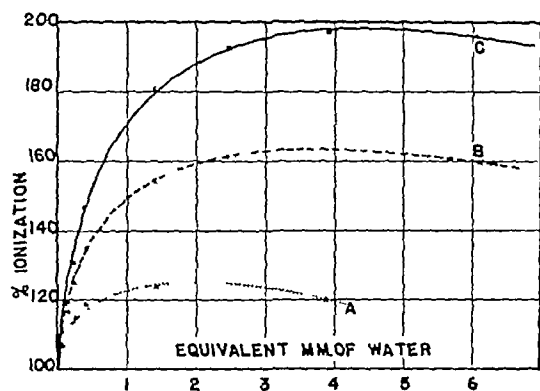


Fig 3 Increase of ionization with increase in thickness of material traversed by canalized gamma rays

Curves A and B of Figure 3 were obtained in this way by using, respectively, the cylinder and cone of Figure 2. In either case the ionization with no material directly over the chamber is taken as 100 per cent and the relative increase with the addition of successive layers of cellophane or celluloid (reduced to equivalent thicknesses of water) is given by the ordinates. It is interesting to note that in the case of the cylindrical collimator the maximum increase found amounts to 25 per cent and occurs with a water equivalent thickness of 2 mm, whereas in the case of the conical collimator the corresponding figures are 63 per cent and 3.4 mm. It would seem from this that the smaller channel is much more effective in removing secondary electrons from the gamma-ray beam. The situation, however, is complicated by another factor.

Considering the geometric relation between the radiating surface and the lead collimators, it is evident that the gamma rays which strike the inner surface of the collimators must produce large numbers of secondary electrons, many of which may reach the ionization chamber. For this reason tests were made with a secondary

filter of bakelite 1.6 mm thick at the end of the cylindrical collimator. The curve obtained under these conditions is labeled C in Figure 3. The great difference between curves A and C, obtained under identical conditions, *except for the bakelite secondary filter*, brings out clearly the very large excess of secondary electrons produced in the collimator wall. This is due to two causes: (1) the high atomic number of the material of the collimator (lead), and (2) the proximity of the lead to both the source and the ionization chamber. The bakelite filter contributed secondary electrons which reached the ionization chamber, but the number of secondary electrons which it absorbed was much greater. Thus, the lead collimator in this case served no other purpose than to provide a narrow beam of gamma rays, which was not even well delimited on account of the penumbra, due principally to the large size of the radiating surface (which we could not change). Accordingly, the removal of a large proportion of the secondary electrons present at the emergence side of the bakelite filter, was due solely to the scattering process whereby many electrons wandered out of the gamma-ray beam in its passage through only 15 cm of air. This is a point of considerable practical importance, because it shows that much can be accomplished in decreasing the number of secondary electrons in a narrow beam of gamma rays by the simple expedient of placing the secondary filter at some distance from the skin. In this connection it might be mentioned that in our pack, as ordinarily used for therapeutic purposes, the placing of the secondary filter at the bottom of the cavity in the lead enclosure through which the radiation passes does not suffice, even though the cavity is lined with brass 1.6 mm thick. The proper thing to do is to place the secondary filter at the mouth of the port which, in turn, should be at a considerable distance from the skin during a treatment. The size of the beam of gamma rays is obviously important and should be as small as possible, consistent with therapeutic requirements. It is also desirable to keep the penumbra as small as

possible. This calls for the use of one or more sources of radiation of small dimensions mounted in properly designed collimators. These conditions cannot be fulfilled satisfactorily unless the radium-to-skin distance is about 20 cm, which, of course, is not practicable unless much larger amounts of radium are available than those used in bombs at present¹.

The limitations of intensity of radiation and (to a certain extent) size of the radiating source, are not present in the case of supervoltage γ -rays. Therefore, suitable provisions may be made to eliminate most of the secondary electrons from the radiation beam before it reaches the skin. The most effective set-up will have to be determined experimentally for any given supervoltage installation.

Referring back to Figure 3 and particularly to curve C, it will be seen that the maximum ionization is obtained with an equivalent water thickness of from 4 to 5 mm. This means that if a patient were to be irradiated under the conditions of the experiment, the maximum ionization would be produced at a tissue depth of about 4 mm. The intervening tissue layers would be ionized to a smaller extent. This is particularly true of the first half-millimeter layer, within which the most radiosensitive cells of the skin are probably located. Accordingly one might reasonably expect a milder skin reaction under these conditions. This point cannot be tested experimentally at this time since the amount of radium in the pack (4 grams) is too small to permit the administration of an erythema dose at a long radium-skin distance in a reasonable length of time.

Since it is important to get some idea of the expected lower biologic effectiveness of gamma rays from which the secondary electrons have been removed wholly or in part, some experiments were carried out using the eggs of the fruit fly *Drosophila mela-*

nogaster as test objects. The small size of the eggs is an important factor since the contribution of secondary electrons by the egg itself is not large. The higher radiosensitivity of this material as compared to



Fig. 4. Arrangement for exposing *Drosophila* eggs to gamma rays.

human skin is advantageous, nevertheless, it is not possible to obtain the desired biologic effect by irradiating *Drosophila* eggs at long distances with our radium pack. For this reason the apparatus shown in Figures 4 and 5 was used in the experiments, relying on a magnetic field to deflect the secondary electrons out of the beam. A lead block with a rectangular slot cut through it was supported between the poles of a strong electromagnet. The source of the gamma-ray beam was a number of radon tubes (marked "Ra Source" in Figure 5) in a lead and brass holder which fitted in the slot and permitted adjustment of the radon-to-eggs distance. The radon tubes were enclosed in gold-platinum capsules of 0.5 mm wall thickness, and a small block of bakelite 6 mm thick, placed above the capsules, served as the usual secondary filter. The magnetic field across the slot directly

¹ There is a possibility which should be explored, that by an appropriate combination of collimators, powerful permanent magnets of the new type, and diaphragms a radium-skin distance somewhat less than 20 cm would be sufficient.

over the radon tubes was increased by inserting at this level soft iron plugs between the pole pieces and the edges of the slot. The direction of the magnetic field was parallel to the axis of the radon tubes and there-

modifications. They were irradiated for varying intervals, incubated at 26°C , and counted on the second day following irradiation. Approximately 1,000 mc of radon was used. With the magnet off, an ex-

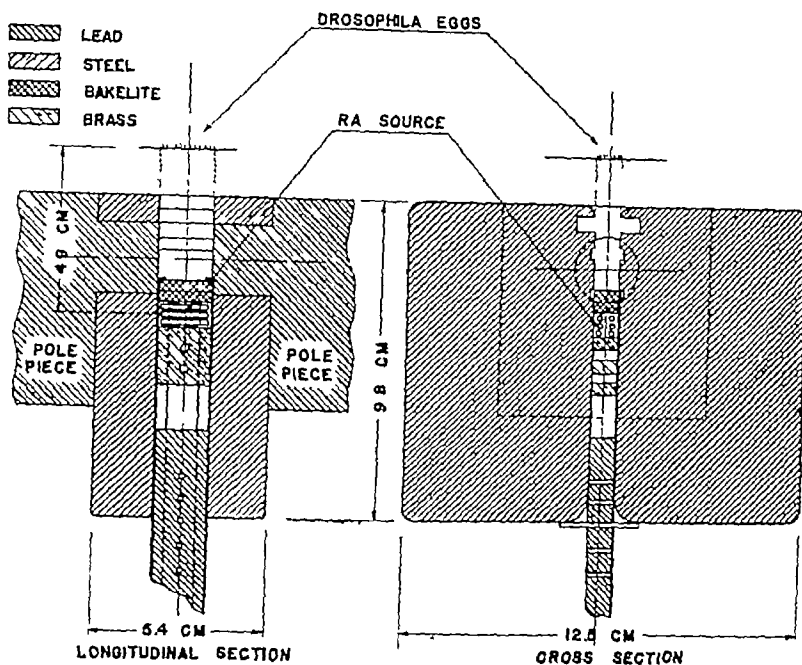


Fig 5 Detail of apparatus shown in Figure 4

fore in the direction of the larger dimension of the rectangular cross-section of the gamma-ray beam. Thus the electrons were deflected sidewise toward one of the wider sides of the slot. Ridges were provided to act as "traps" for these electrons. The eggs were suspended on the under side of a piece of thin fabric (chiffon) 4.9 cm above the radon. By referring to the cross-section in Figure 5, it will be seen that gamma rays and secondary electrons liberated in the sides of the lead slot as well as in the bakelite block, will reach the eggs. When the magnet is turned on, the beta particles are deflected to one side or the other, depending on the direction of the field, and a great many are either caught in the lead sides with the slots or pass to one side of the eggs.

For the experiments, eggs were obtained according to the method originally described by Packard (12), with some slight

posures of 27,000 millicurie-minutes was required to kill 50 per cent of the eggs. With the magnet on, other conditions remaining the same, the corresponding exposure was found to be 50,000 millicurie-minutes. The complete results of this experiment are shown graphically in Figure 6. It is evident that in this case the magnetic field removed enough secondary electrons to practically halve the lethal effect of the beam of radiation. It should be noted in this connection that even if all the secondary electrons were prevented from reaching the eggs, the gamma rays would still affect them, through the secondary electrons liberated within the eggs themselves. Whether the lethal effect observed, in the tests with the magnet on, may be accounted for solely on this basis, or was partly due to secondary electrons which reached the eggs in spite of the magnetic field, is diffi-

cult to say On account of the necessity of exposing the eggs at relatively short distances from the source, the conditions for the complete elimination of secondary electrons were not ideal

hatching point, with the magnet on, is from 32,000 to 48,500 millicurie-minutes in the curves of Figure 7 That is, the exposure had to be increased 50 per cent to produce the same effect on the eggs when the mag-

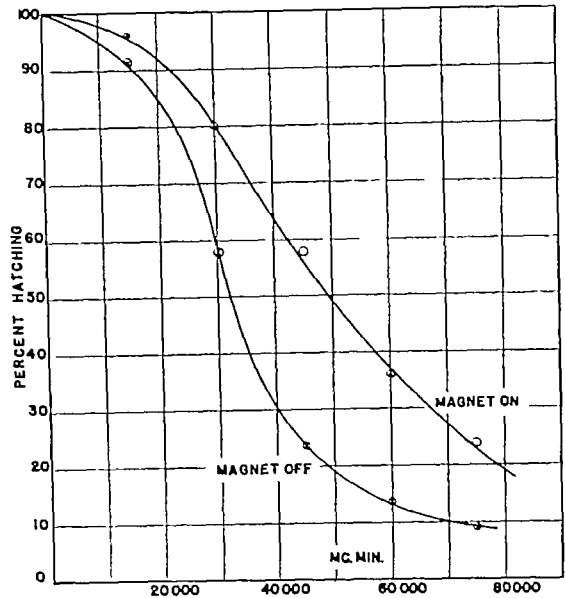
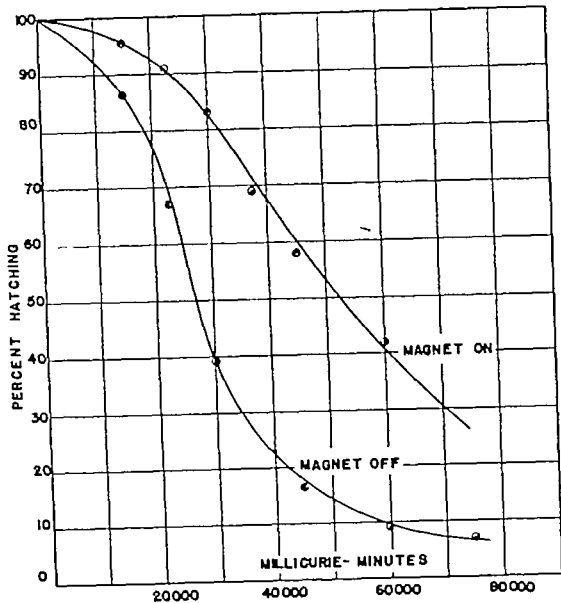


Fig 6 Survival curves of *Drosophila* eggs exposed to gamma rays in air with and without magnetic field
Fig 7 Survival curves of *Drosophila* eggs exposed to gamma rays through 1.03 mm celluloid, with and without magnetic field

In order to determine the lethal action of the radiation after traversing some matter and thus acquiring more secondary electrons, eggs were exposed on top of celluloid sheets which intercepted the vertical beam of radiation Exposures were made with and without the magnetic field for different thicknesses of celluloid The results are shown in Figures 7 and 8 It will be seen from Figure 7 that the 1.03 mm sheet of celluloid used in the experiment was not sufficient to provide the full quota of secondary electrons removed by the magnetic field In fact, there is still a marked difference in the lethal action of the gamma-ray beam with and without the magnetic field From this, one may deduce that a considerable proportion of the secondary electrons in the gamma-ray beam passed through the 1.03 mm sheet of celluloid when the magnet was not turned on The increase in exposure at the 50 per cent

netic field was present With sheets of celluloid 2.78 and 3.78 mm thick, directly under the eggs in the path of the radiation, no significant differences were found with the magnet on and off (Fig 8)

In these experiments particular attention was paid to the exposure of eggs with and without the magnetic field under as nearly the same physical and biologic conditions as possible On the other hand, it was not found practical to maintain the same biologic conditions for the eggs from one set of experiments to another Thus the radiosensitivity of the eggs was not the same in the three sets of experiments shown in Figures 6, 7, and 8, as indicated by the fact that the three curves obtained without the magnetic field are somewhat different The relative values in each set, however, do not suffer from this limitation They are given in Figure 9 in terms of the percentage increase in millicurie-minutes necessitated

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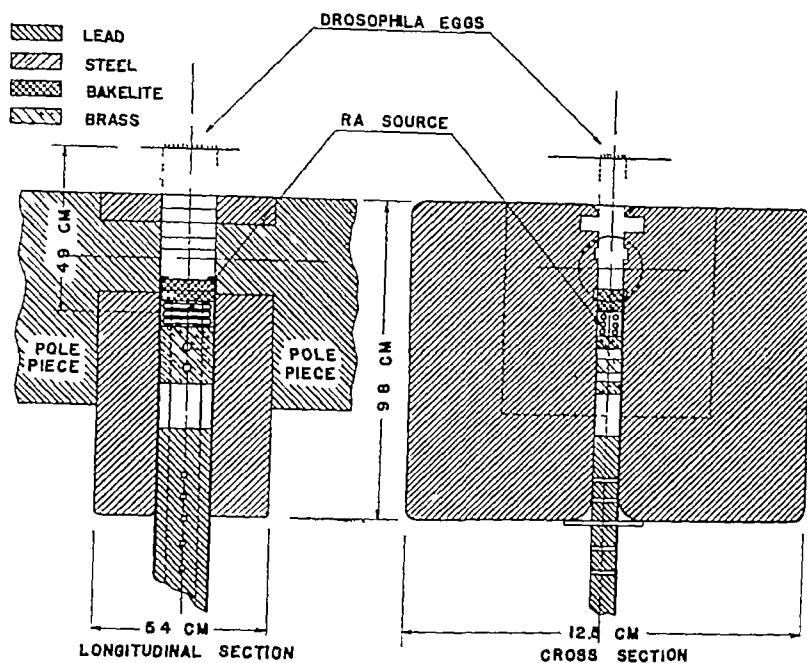


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posure of 27,000 millicurie-minutes was required to kill 50 per cent of the eggs. With the magnet on, other conditions remaining the same, the corresponding exposure was found to be 50,000 millicurie-minutes. The complete results of this experiment are shown graphically in Figure 6. It is evident that in this case the magnetic field removed enough secondary electrons to practically halve the lethal effect of the beam of radiation. It should be noted in this connection that even if all the secondary electrons were prevented from reaching the eggs, the gamma rays would still affect them, through the secondary electrons liberated within the eggs themselves. Whether the lethal effect observed, in the tests with the magnet on, may be accounted for solely on this basis, or was partly due to secondary electrons which reached the eggs in spite of the magnetic field, is diffi-

with the physical characteristics of the radiation and medium. Accordingly it is only within a certain layer of tissue on the incidence side that a subnormal degree of ionization may be expected. The thickness of this tissue layer depends on the quality of the radiation which determines the penetration range of the secondary electrons. In the case of ordinary x-rays the range in tissue of the secondary electrons is very short and the tissue layer of subnormal ionization is very thin. In the case of gamma rays it is of the order of a few millimeters.

4 Skin damage of the degree tolerated in present-day radiation therapy is probably limited to the epidermis, inasmuch as there is eventually almost complete recovery. The thickness of the human epidermis varies from point to point but, in general, it is well within two millimeters. Accordingly, by removing the secondary electrons from a beam of gamma rays before it reaches the skin, one may expect to reduce skin damage considerably.

5 Physical experiments described in the body of the paper show that in the case of gamma rays the tissue layer of subnormal ionization is about four millimeters.

6 Biologic experiments with *Drosophila* eggs as test objects confirm this result, and demonstrate that the biologic effectiveness of gamma rays is markedly reduced by the removal of secondary electrons.

7 It has been impossible to test by actual experiment the decrease in skin damage resulting from the removal of electrons from a gamma-ray beam, due to the fact that the amount of radium required for this purpose (of the order of twenty grams) is not available.

8 It is suggested that practical application of the findings reported here be made to

supervoltage x-ray therapy at voltages in the neighborhood of one million. The advantage may be expected to be greater with still higher voltages.

9 The experimental demonstration of the marked reduction in the electron content of a gamma-ray beam by suitable canalization and spacing of filters, facilitates the practical application of the principle.

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by the presence of the magnetic field, for different thicknesses of celluloid in the path of the rays, reduced to equivalent thicknesses of water

The results of the biologic experiments are qualitatively in accord with the results

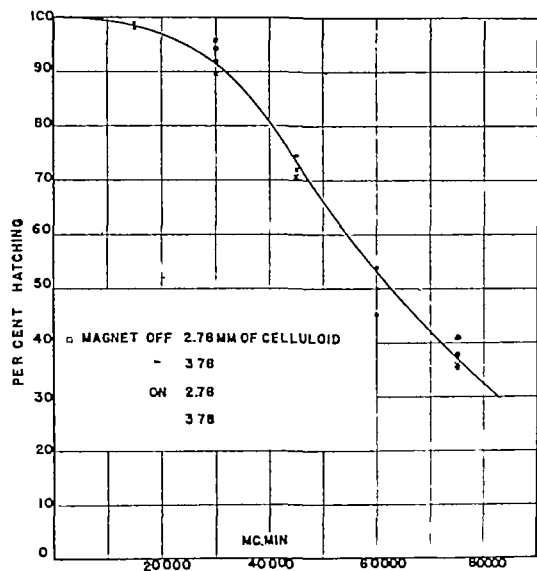


Fig 8 Survival curves of *Drosophila* eggs exposed to gamma rays through 2.78 or 3.78 mm of celluloid with and without magnetic field

of the ionization measurements previously described. A quantitative agreement could not be expected, of course, on account of the marked difference in experimental conditions. It is evident that a gamma-ray beam partly stripped of the accompanying secondary electrons is considerably less effective biologically than one containing the full complement of electrons. The acquisition of additional electrons takes place rather rapidly as the beam traverses matter, but nevertheless the difference is considerable within the first one or two millimeters of tissue. If erythema and epithelitis are due to tissue damage which occurs within this depth range, the removal of secondary electrons from a beam of very hard radiation may be expected to prove of considerable practical value in radiotherapy. However, full advantage of this phenomenon cannot be taken until x-ray

apparatus operating at potentials above one million volts has been developed

SUMMARY

1 Any beam of x-rays or gamma rays contains high speed secondary electrons

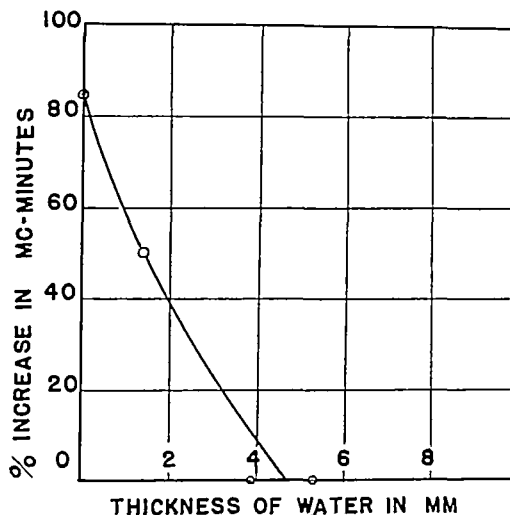


Fig 9 Relative increase in millicurie minutes necessary to produce the same lethal effect on *Drosophila* eggs through different thicknesses of material, when magnetic field is on

originating in the filter and air traversed by the radiation. These electrons are responsible for the ionization produced by the radiation. In turn, ionization is responsible for the biologic action of radiation. Thus if it is possible to remove the secondary electrons from a beam of radiation, its biologic effectiveness should be reduced considerably.

2 Secondary electrons may be removed from a beam of radiation by means of a magnetic field suitably applied. They may also be removed to a considerable extent by proper canalization of a narrow beam, on account of the fact that they do not travel in straight lines.

3 When a beam of radiation stripped of secondary electrons traverses a tissue, it gradually acquires secondary electrons due to the interaction of radiation and matter, and beyond a certain depth it contains the appropriate quota of electrons consistent



Fig 1

Fig 1 Case 1 Patient N S male aged 49 Encephalogram shows compression of right lateral ventricle and displacement of ventricular system toward the left *Note* Patient with no adequate history presents classical signs and x-ray findings of subdural hematoma



Fig 2

Fig 2 Case 2 Patient S O male, aged 40 Encephalography discloses moderately enlarged right lateral ventricle *Diagnosis* laceration edema of brain with minimal subdural hemorrhage

tion of ventricles, four showed compression of ventricles, and 13 showed air over the cortex of the frontal lobes

In 1932, Flugel reported 38 cases showing symptoms of varying periods after the injury which in the majority of cases was more than a year In seven of these the ventricles failed to fill with air, in 12 there was displacement of a ventricle, in 20 cases one lateral ventricle was larger than the other, in 15 cases the third ventricle was not demonstrated, and in one case it was dilated In this series of cases one-third of the patients showed no objective neurological signs, another one-third had epileptic seizures

During the same year, Hauptmann reported encephalographic studies in 40 cases with post-traumatic sequelæ, but without localizing signs of brain injury In most instances, the encephalograms were made four or more years after the injury The ventricles were dilated in 27

cases, one lateral ventricle alone dilated in 12 cases, the third ventricle alone di-



Fig 3 Case 3 Patient F G Encephalograms in October 1936 disclose bilateral dilatation of ventricular system Mid line shift toward right side associated with slight deformity of left lateral ventricle

ROENTGENOLOGIC FINDINGS OF POST-TRAUMATIC SEQUELAE OF HEAD INJURIES

AN ENCEPHALOGRAPHIC STUDY¹

By J TOWNSEND TRAVERS, M D , *New York City*

IT is a well-recognized fact that, after recovery from the acute effects of a head injury, many patients continue to show symptoms, or later develop symptoms, which are apparently the result of the trauma. In some instances, there are such general symptoms as headaches, vertigo, sleep disturbances, and mental changes, while in others, there are clinical signs of focal organic damage to the central nervous system.

In a review of 255 cases observed for a period of from one to five years after head injury, Glaser and Shafer found that 80 per cent developed subjective symptoms, and 32.5 per cent developed organic neurologic signs. Mental disturbances and "convulsive states" were the only symptoms that developed more than three months after the injury, all other symptoms appearing within a short time. Neurologic signs, it was noted, were much more frequent in cases with depressed fracture of the vault than in cases without skull fracture. The highest percentages of both signs and symptoms were seen following fractures of the base and vault. It is unfortunate that, in this very interesting study of the sequelae of head injuries, roentgenographic observations were made only in order to ascertain the presence and location of skull fractures, but no encephalographic studies were made.

In spite of the increasing use of encephalography, its value in the study and evaluation of the sequelae of head injuries appears to be but little appreciated. Many recent reviews of such sequelae, though none of as large a series as that of

Glaser and Shafer, fail to mention the use of encephalography (see Bing, Dickerson, Gordon, Horrax, and Stone and Brams). In 1935, Wechsler reported a series of 100 cases showing symptoms attributed to a previous head injury, the majority were litigation cases. All these patients, he notes, had records of roentgenographic examinations of the skull, "a great many" records of lumbar punctures and "a few had reports of encephalographic studies"—but he does not discuss these records further. He recognizes the value of encephalographic studies as made by others, however, in showing "the extent of ventricular and brain changes in patients whose main complaints were of a subjective nature." In this series of 100 patients, he further notes, 74 had subjective complaints and only 26 had "major or minor evidence of organic involvement of the nervous system."

In 1925, Foerster and Wartenberg, and in 1926, Schwab reported encephalographic studies on patients who showed symptoms after head injuries. The patients studied showed such symptoms as fatigue, insomnia, headache, dizziness, etc., but no marked objective neurological signs, yet the encephalograms showed definite evidence of damage to the brain. In 1930, Pancoast and Fay, and Foerster and Penfield reported similar findings (Friedman).

In 1931, Swift reported a study of 100 cases of post-traumatic sequelae resulting from head injuries, 76 of these patients had been unable to resume work after the injury. The chief symptoms were headache, dizziness, general weakness, disturbances of vision and hearing. Encephalographic studies were made in 50 cases. Of these, 27 showed "practically normal" findings, two showed displacement of the ventricles to the left, four showed dilata-

¹ I am greatly indebted to Dr. Foster Kennedy of the Neurological Department and to Dr. K. M. Bowman of the Psychopathic Division of Bellevue Hospital for the use of the clinical data and also to Dr. Lewis J. Friedman, Director of the X-ray Department of the same institution for his kind co-operation.



Fig 13

Fig 13 Case 10, Patient R S, male, aged 50 Encephalograms disclose dilated and deformed left ventricle with marked mid-line shift to the left No air revealed in the cortical pathway *Diagnosis* subdural hematoma on right side *Comment* subdural hemorrhage is frequent in chronic alcoholics with many falls (often simulates psychosis)



Fig 14

Fig 14 Case 11, Patient C C Encephalography reveals moderate dilatation of lateral and third ventricles, most marked on right side Frontal sulci coarse Basal cisterna enlarged *Conclusions* post-traumatic cerebral trophy

ment of the left ventricle due to an old calcified hematoma

epilepsy, distortion and wandering of the ventricles occur and are "indicative of scarring"

Glaser, in 1934, notes that, in traumatic

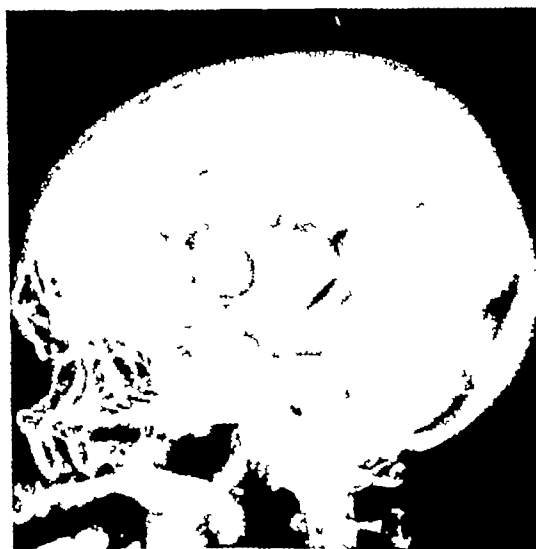


Fig 15

Fig 15 Case 12 Patient I K, male, aged 60 Lateral view Encephalogram discloses enlarged left ventricle, craniotomy discerned *Diagnosis* post-traumatic brain atrophy



Fig 16

Fig 16 Case 12 Postero-anterior view



Fig 9

Fig 9 Case 8 Patient N Q Encephalograms Aug 3 1935 disclosed dilated left lateral ventricle with dilated subarachnoid spaces over left side (Left internal carotid ligated in 1927) *Impression* post traumatic brain porencephaly



Fig 10

Fig 10 Case 8 Irregular collections of air pockets surrounding the dilated left ventricle *Impression* brain atrophy, post traumatic

In 1934, Lippens and Desjardin reported three cases studied by encephalography. In one case the findings were nor-

mal, in one the lateral ventricles were displaced toward the site of the injury, and in one there was deformity and displace-



Fig 11

Fig 11 Case 9 Patient J C Encephalograms reveal incompletely filled and deformed right ventricular system. Left ventricular system not demonstrated. Right and left sided craniotomies discerned. *Diag* nosing bilateral subdural hematoma



Fig 12

Fig 12 Postero-anterior view of same case

ment of both ventricles to the left, and "little if any subarachnoid air over the right cerebral cortex." At operation a large subdural hematoma was removed from the right side, after which the patient made a

the lesion, with compression and deformity of the ventricle on the side of the lesion, or (in one instance) a failure to demonstrate this ventricle at all. Failure of the subarachnoid space to fill on the side of the

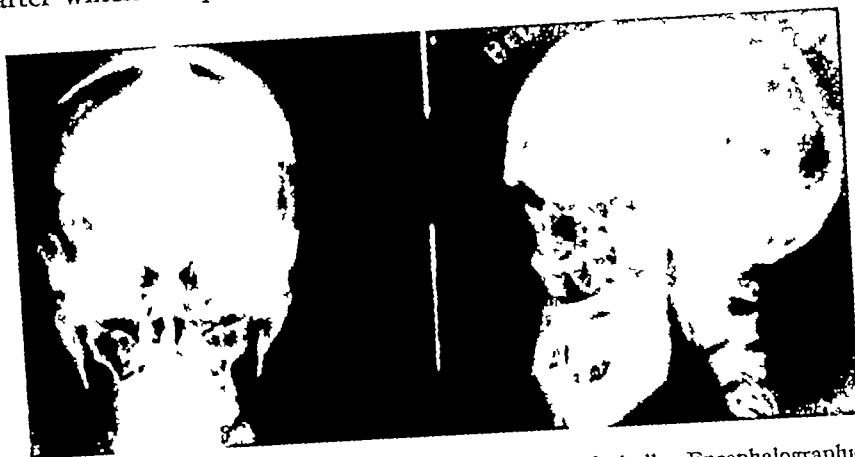


Fig 19 Case 14 History of trauma no fracture of skull Encephalographic observation discloses presence of large collections of air in fronto-parietal regions Case illustrates air in subdural spaces but no evidence of brain atrophy

good recovery Lindemulder stated that "the demonstration of a subdural hematoma by encephalography is rare." He noted but one other case, reported by Dickerson, in 1929.

At a meeting of the New York Neurological Society in 1936, Dyke reported an encephalographic study in a case of subdural hematoma, in which the encephalogram showed a large collection of air in the subdural space over the left cerebral hemisphere projecting ventrally and laterally. No air was found in the subarachnoid space or in the ventricles. The diagnosis of subdural hematoma was confirmed at operation.

In our own experience, we have found encephalography of definite value in the study of post-traumatic sequelæ, and particularly in the differential diagnosis of subdural hematoma.

In a recent series of 14 cases with post-traumatic sequelæ of head injuries, from the Neurological and Psychopathic Divisions of Bellevue Hospital, there were four cases of subdural hematoma (confirmed by operation). The encephalographic studies in these cases revealed a marked shift of the ventricular system to the side opposite

lesion was also discerned in another instance.

In only one case was a diagnosis of subdural hematoma made pre-operatively which could not be confirmed at operation. In this case, a second operation was performed and a cannula inserted into the left temporal area. This disclosed a drop of dark brown fluid, indicating an intracerebral hemorrhage, with coagulation of the blood. The patient made a good recovery. The pre-operative encephalogram showed a definite shift of the ventricular system to the right—the side opposite the lesion—on which the diagnosis of subdural hematoma was based, but further study of this encephalogram showed that the characteristic deformity of the ventricle on the side of the lesion was not present.

In the remaining nine cases, there was roentgenologic evidence of brain atrophy. In three cases there was enlargement of both lateral ventricles, and in two of these a corresponding dilatation of the third ventricle. In all three cases the cerebral sulci were coarse, an indication of cortical atrophy, and in one case the basal cisternæ were enlarged, showing atrophy of the adjacent structures. In this latter case

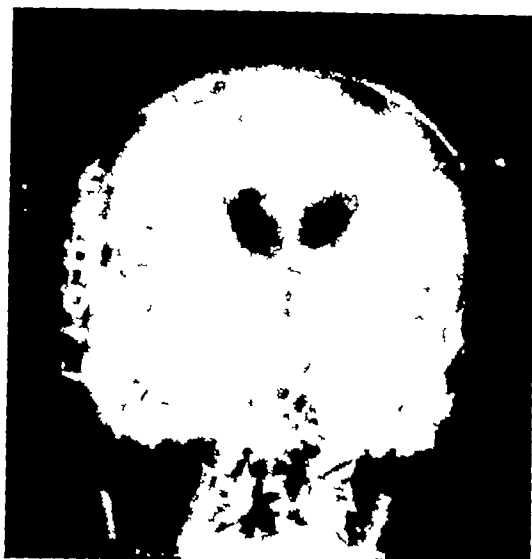


Fig 17

Fig 17 Case 13, Patient H S male aged 38 Postero-anterior view disclosing enlarged ventricles



Fig 18

Fig 18 Case 13 Encephalography reveals symmetrically distended ventricular system, cerebral sulci coarse in frontal region *Diagnosis* post traumatic brain atrophy

It will be noted that in these various reports, nothing is said of the encephalographic findings in subdural hematoma. This is generally considered to be an unusual complication of brain trauma. But Leary, the Medical Examiner of Suffolk County, Massachusetts, in his investigations of the many deaths by violence concluded that subdural hematoma occurs more frequently than has been supposed. He reported a series of 50 cases mostly the result of trauma, in none of which were encephalographic studies made. He stated that the diagnosis of subdural hematoma is often difficult. In some of these cases of subdural hematoma, death occurred soon after the injury, but in others the condition became chronic. In both types, in cases in which there resulted membrane formation, the lesion was situated over the cerebral convexity "almost without exception," and usually in the fronto-parietal region. In one of the cases reported by Friedman, operation was performed because of the presence of focal signs, before the encephalogram was made, and no hematoma was found. The encephalogram, made later because of the persistence of symptoms, showed dilatation of the ven-

tricles, more pronounced on the right with migration of the ventricular system to the site of the lesion, the final diagnosis was post-traumatic cerebral scar.

In 1932, Gardner reported seven cases of traumatic subdural hematoma. No encephalographic studies were made in these cases. Five of these patients recovered following operation, and two died with the condition undiagnosed. Lateralizing signs, he notes, "are not of great significance, since the lesion is often found on the side opposite to that which is indicated by the symptoms."

W D Abbott in 1936 reported a series of 16 cases of subdural hematoma, the chief symptoms noted were headache, personality changes, convulsions, and vomiting. Encephalography was done in six of these cases, where it "was necessary for localization." In the 15 cases operated on there were four deaths.

In 1931, Lindemulder reported a case of subdural hematoma probably due to slight cerebral trauma, as the patient was struck on the head on two occasions, five and three months previously. The encephalogram showed a dilated left ventricle and a small compressed right ventricle, with displace-

tiating subdural hematoma from non-surgical lesions It may aid in localizing a subdural hematoma It has the added advantage, of being of frequent value, as a therapeutic measure

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one of the lateral ventricles was slightly larger than the other. In five of these nine cases, one lateral ventricle was dilated and the sulci were coarse, in one case porencephaly was noted. In these five cases,



Fig 20 Case 15, Patient C B Encephalograms reveal large collection of air in posterior fossa. *Diagnosis* post traumatic cerebellar atrophy

there was almost complete relief of symptoms following encephalography. Any displacement of the ventricle in these cases of cortical atrophy was toward the site of the lesion, due to cortical fibrosis. In one case—in which the exact diagnosis was doubtful—there was air in the subdural space but no evidence of brain atrophy.

SUMMARY

Symmetrical filling of the ventricles and subarachnoid spaces, or dilatation of one or both ventricles without a ventricular shift definitely rules out a subdural hematoma in our experience. It should be noted also that, in subdural hematoma, the ventricular shift is *away from* the side of the lesion, while in the presence of scar tissue resulting from a laceration of the brain there may be a ventricular shift *toward* the lesion. As the clinical symptoms of subdural hematoma may simulate those of other post-traumatic sequelæ, the differential diagnosis is of importance, for surgical

treatment is definitely indicated in subdural hematoma. The earlier the operative interference, the better the results. In other cases with similar clinical symptoms, surgery may be definitely contraindicated. The encephalogram is also of value in the localization of a subdural hematoma, for the localizing signs and symptoms are often confusing.

Encephalography has been used chiefly in the study of post-traumatic sequelæ of brain injury to determine whether or not there is an actual brain lesion to account for the subjective symptoms which are sometimes designated as neurotic. In a large percentage of such cases, actual lesions are demonstrable by this means. We would urge the more general use of encephalography following brain injury for a more exact differential diagnosis of the resulting lesions, especially with a view to determining whether or not surgery is indicated.

Encephalography by the usual technic is not harmful in patients with sequelæ of brain injury. It may be of definite therapeutic value, not only in patients with adhesions but also in patients with cortical atrophy. Marked improvement in symptoms may result from the injection of the air. Bennett and Hunt noted that there was relief of symptoms following encephalography in about half of their cases. Grant noted that 50 per cent of his cases of post-traumatic headache observed over a period of from 12 to 24 months were relieved by encephalography, and a smaller percentage of cases of post-traumatic epilepsy were also relieved. We have also noted definite relief of symptoms in many of our cases following encephalography.

CONCLUSIONS

The reports cited and our own cases show the very definite value of encephalography in the study of post-traumatic sequelæ of brain injuries. The encephalogram has demonstrated that even subjective symptoms may have a definite organic basis resulting from injury to the brain tissue. It is of special aid in differen-

methods which we have used and developed during the last six years, and which in our hands have given excellent results

- (4) Right and left oblique views of the lumbosacral spine showing the intervertebral joints

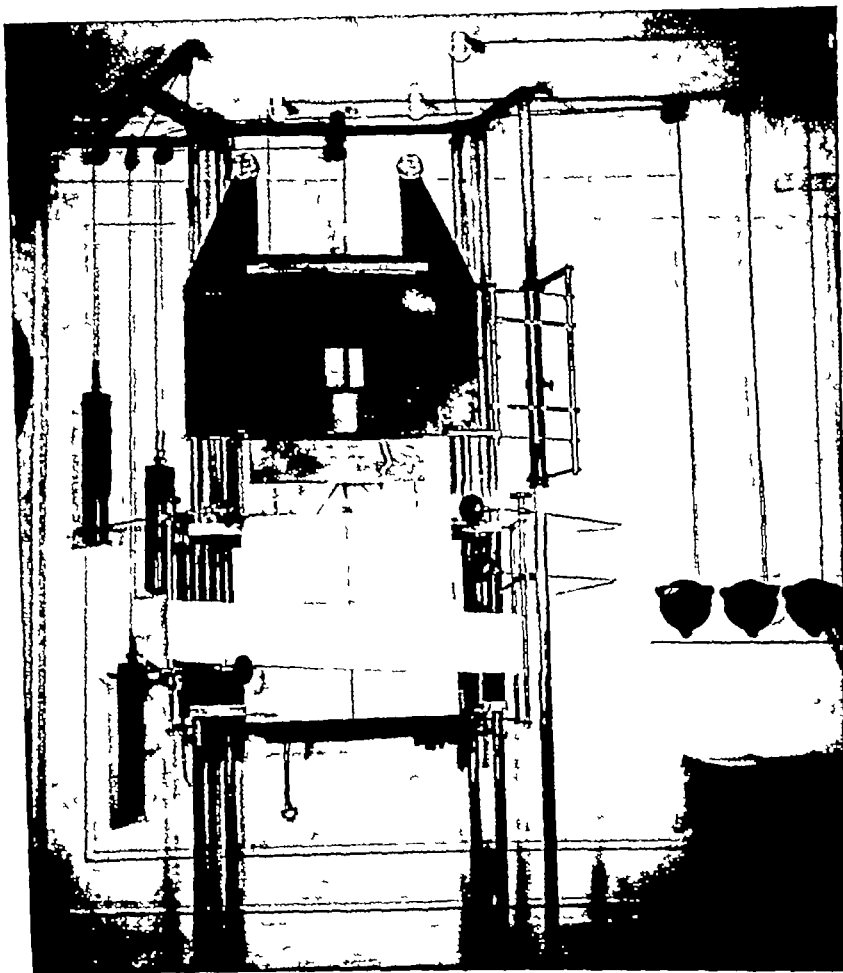


Fig 1

In working out these methods, I always have in mind that it is necessary to standardize the technic in order to facilitate the routine work of the x-ray department

A complete roentgen analysis of the spine consists of the following exposures

- (1) Anteroposterior and lateral long-distance views of the lumbodorsal spine, with the patient standing or sitting
- (2) Anteroposterior and lateral long-distance views of the cervical spine, with the patient sitting
- (3) Anteroposterior cone film of the lumbosacral and sacro-iliac region

- (5) Right and left oblique views of the dorsal spine showing the intervertebral joints in this region

(1) In taking the anteroposterior and lateral views of the entire spine, or at least the lumbodorsal section, we follow the technic of Walter Jaeger, which was first published in 1931 (3 and 4). The underlying principles of telerradiography of the spine are as follows

By making the film-focus distance two meters or more, the relation of focus-film to object-film distance is so favorable, for obvious geometrical reasons, that the spine, in spite of its anatomical position within

ROENTGEN ANALYSIS OF THE SPINE

WITH DESCRIPTION OF SOME NEW TECHNICAL INSTRUMENTS

By H JORDAN, M D , *New York City*

DESPITE the general advance in x-ray technic, the improvement of x-ray machines, and the greater sensitivity of the films, there is still room for much improvement in the radiography of the spine. It has been my experience that radiography of the spine lags behind that of other parts of the body. In recent years the need for more efficient and more detailed roentgenograms of the spine has been generally recognized by the profession, especially in the fields of orthopedic and traumatic surgery. This constantly growing demand has not yet been satisfactorily met.

To mention a few instances fractures and dislocations of the cervical spine require lateral views without distortion, showing the entire cervical spine from the first cervical to the third dorsal vertebra. It was only a short time ago that Byron Stooky (6) deplored the difficulty of obtaining well defined roentgenograms of the cervical spine in cases of fracture and dislocation.

For the analysis of scoliosis and the evaluation of the results of various types of treatment, radiographs have to be taken with the patient in a standing position, and if possible in such a way that all the details of his position may be recorded and check-up x-rays taken under exactly identical conditions.

More and more attention has been given recently to the pathology of the small joints of the spine and the intervertebral facets forming these joints, and the conviction has grown that arthritis or arthrosis of these small joints may be of greater importance than the more conspicuous changes in the intervertebral discs and the vertebral bodies, *e g*, in spondylosis. This is especially true of the lumbosacral region in the perplexing problem of lower back pain.

The spine does not lend itself so easily to roentgenography as do other parts of the body, the extremities for instance, and this is due chiefly to its anatomy. The spinal column is very large in its longitudinal dimension and very small in the other two. It is situated within the trunk and the pelvis in such a way that it is not easily revealed by the x-ray without interference from overlying structures. Furthermore, the spine has a number of natural curves, which are frequently increased by deformities, therefore, various sections of the column have a different object-film distance. Finally, the single units of the spine are so constructed that certain details such as the small intervertebral joints or the pedicles, which may be of the greatest interest, cannot be visualized in one and the same exposure.

Another difficulty arises in attempting to radiograph the whole spine, or a sufficient part of it, on one film when the usual small film-focus distance is used. Not only does a film-focus distance of less than one meter allow but a small section of the spine to be radiographed at one time, but it can show only a few vertebræ without distortion, the majority of them being so far off-center that they do not permit accurate observation.

The desire to have a complete picture of the entire spine on one film has led to the use of a 14 X 36-inch film and a Potter-Bucky diaphragm of the same size. In order to eliminate the difficulties caused by the various densities of different sections of the body, Arthur W. Fuchs (2) introduced an ingenious filter which seems to give satisfactory detail throughout the spine, it does not, however, eliminate distortion as long as it does not increase the film-focus distance to more than 54 inches.

In the following, I should like to report

at one end an eye-piece (A) The interior of this tube is black so as to eliminate glare Seven centimeters from the distal

ever, is used In taking the anteroposterior view of the cervical spine, the patient sits on the stool so far away from the frame

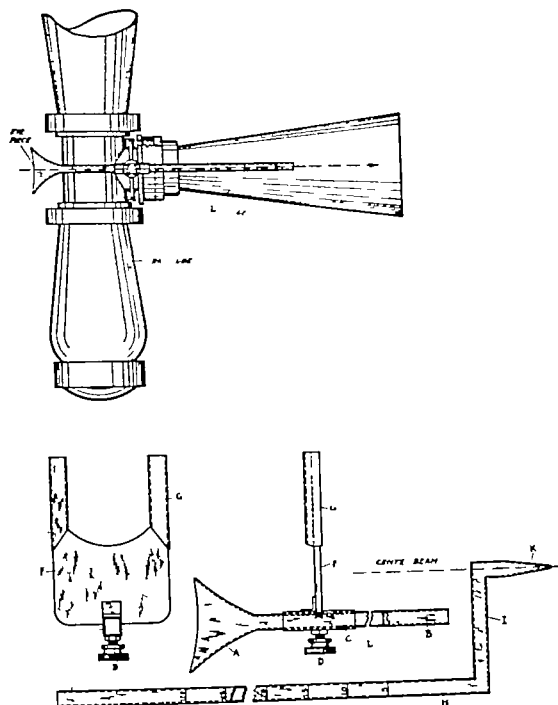


Fig 3

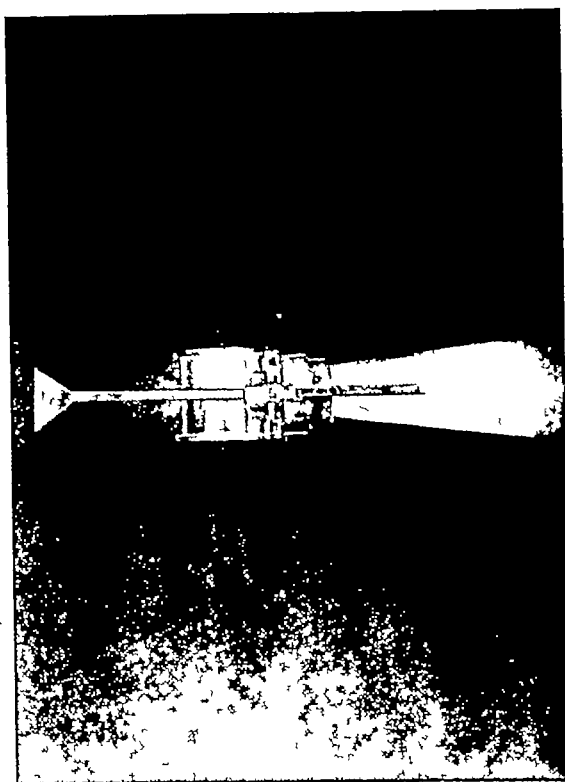


Fig 4

end, there is a cross-wire (L) The telescope is attached to the tube exactly parallel with the center beam With this little device it is very easy to center the focus on the object

As a rule, the anteroposterior view is taken with the patient sitting on a stool centered to the midline of the upright Potter-Bucky diaphragm The sitting position has the advantage of overcoming the lumbar lordosis by flexing the hip-joints For the examination of scoliosis, and also for control of the action of spinal braces, the anteroposterior views are taken with the patient standing

(2) *The Cervical Spine*—The anteroposterior and lateral views of the cervical spine are taken with the patient sitting, and without the use of the Potter-Bucky diaphragm The anterior diaphragm, how-

that it will be possible to get his neck in close contact with the cassette The patient is instructed to open and close his mouth rhythmically during exposure so as to dissipate the contour of the jaw In order to obtain a good lateral view, the sagittal plane of the patient's skull and cervical spine must be perfectly parallel with the film Fixation in the desired position is maintained by the old Baer "skull ring" (Fig 5)

(3) *The Lumbosacral Region*—There are three requirements for obtaining satisfactory films of the lumbosacral junction and the sacro-iliac joints (a) the lumbar lordosis must be straightened out in order to have this section as close to the film as possible, (b) secondary radiation must be cut down to a minimum in order to get good contrast, so that in addition to the

the trunk, and its curvatures, is depicted on the film practically without distortion. Therefore, the exposure obtained may be

long exposure, therefore, a motor-driven Potter-Bucky diaphragm, which permits any length of exposure, is used. A

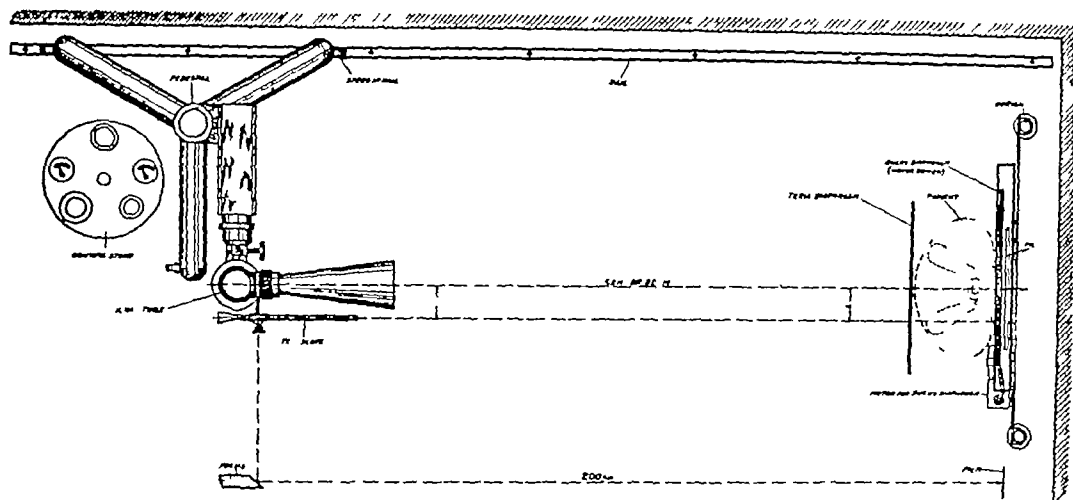


Fig 2

used for the determination of the axes of the vertebral bodies as well as the axis of the entire spinal column.

There is, however, another feature which makes the long-distance radiogram of the spine even more valuable. By increasing the film-focus distance to two meters or more, a very interesting phenomenon appears, a "compensating effect" (*Ausgleichseffekt*—Jaeger). Without the use of additional filters, as employed by Fuchs, the entire spine is shown on the film with very little variation in density. The idea of taking long-distance radiographs of the spine with regard to this compensating effect was, so far as I have been able to find, first used by Baer, of Zurich, in 1916. Jaeger reports that Denis Mulder, of Bandoeng, Java, has taken roentgenograms of an entire person with a film-focus distance of from eight to twelve meters, thereby obtaining a complete "compensating effect," the patient's hair and nails being just as well defined as were the large bones of the body.

In order to standardize and simplify the teleradiography of the spine, certain technical arrangements have to be made. The long film-focus distance necessitates

second diaphragm is added in front of the patient in order to eliminate as much of the secondary radiation as possible, thereby giving the film the maximum contrast. Following the example of Jaeger, we have made the following arrangements:

Three pairs of pillars carrying the upright Potter-Bucky diaphragm, the compression band and other means of fixation for the patient, and the anterior diaphragm are provided (Fig 1). The distance and relative position of the tube, film, and object are permanently fixed in a rectangular position, as shown in Figure 2. This diagram illustrates the position of the patient between the anterior diaphragm and the Potter-Bucky. The height of the whole system varies according to the patient's size. All the uprights are graduated in order to facilitate the adjustment and to record it.

The long film-focus distance and the narrow opening of the anterior diaphragm necessitate the most exact centering of the entire system, and especially of the focus. For this purpose I have designed a telescope (Figs 3 and 4). This consists of a rectangular metal tube (B), 1 cm in diameter and 31 cm long, which carries

the advantages of the various roentgenograms obtained by the technic described, I should like to make a few general remarks

In roentgenography of the spine more than in the routine roentgenography of the extremities, the results depend upon a very exact technic. The position of the patient for each exposure is just as important as is the correct centering of the radiation. Practically all of the special views described above throw a heavy burden upon the x-ray tube, demanding a great intensity of radiation for long film-focus distance, and long exposure time, in which it is difficult to keep the patient from moving if his position is not entirely fixed and comfortable. Correct values of kilovoltage, milliamperage, and exposure time are not so important as having the whole system properly centered and avoiding secondary radiation as far as possible. Good compression of the object, the use of the smallest cones, and for the long-distance views the use of an anterior diaphragm, help considerably to obtain better contrast. A very careful dark-room technic, with special attention to correct time-temperature

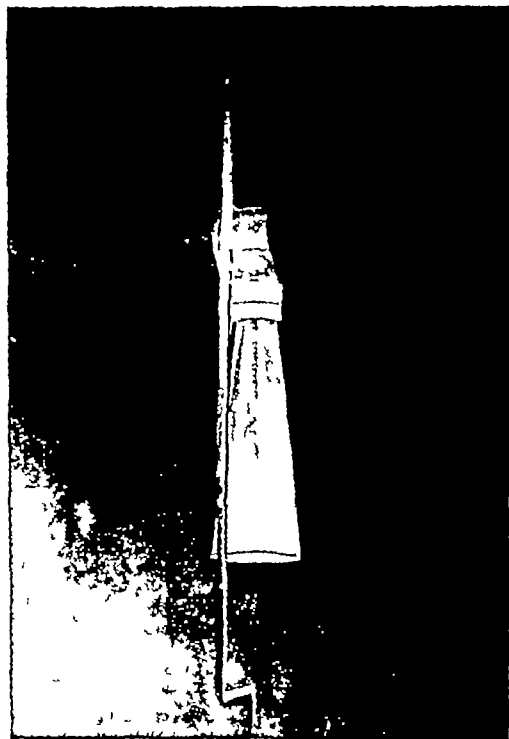


Fig 6

developing, is a prerequisite for such delicate x-ray work

Proper centering of the object is pos-



Fig 7

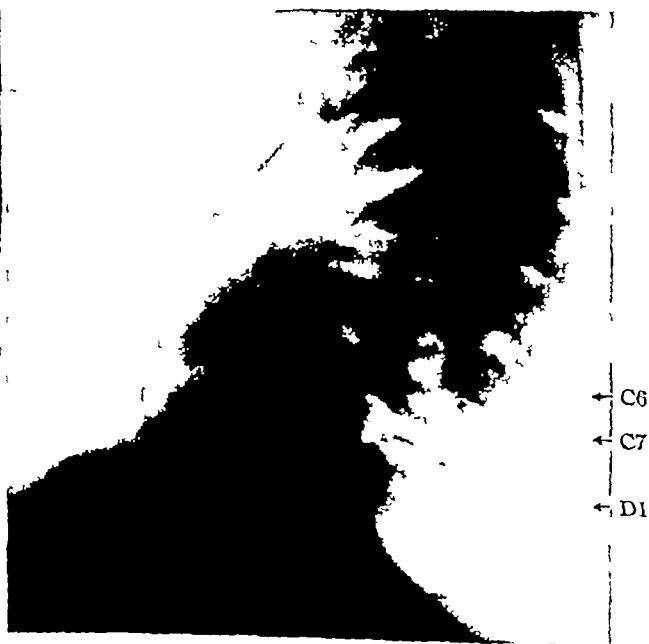


Fig 8

Potter-Bucky diaphragm a small cone and a strong compression of the soft parts must be used, and (c) the patient must be cleaned out thoroughly, with special attention to gas formation

the patient has to rest on either side, with the frontal plane of his body at an angle of 45 degrees to the plane of the film

(5) *The Dorsal Region*—Finally, the intervertebral joints of the dorsal spine are

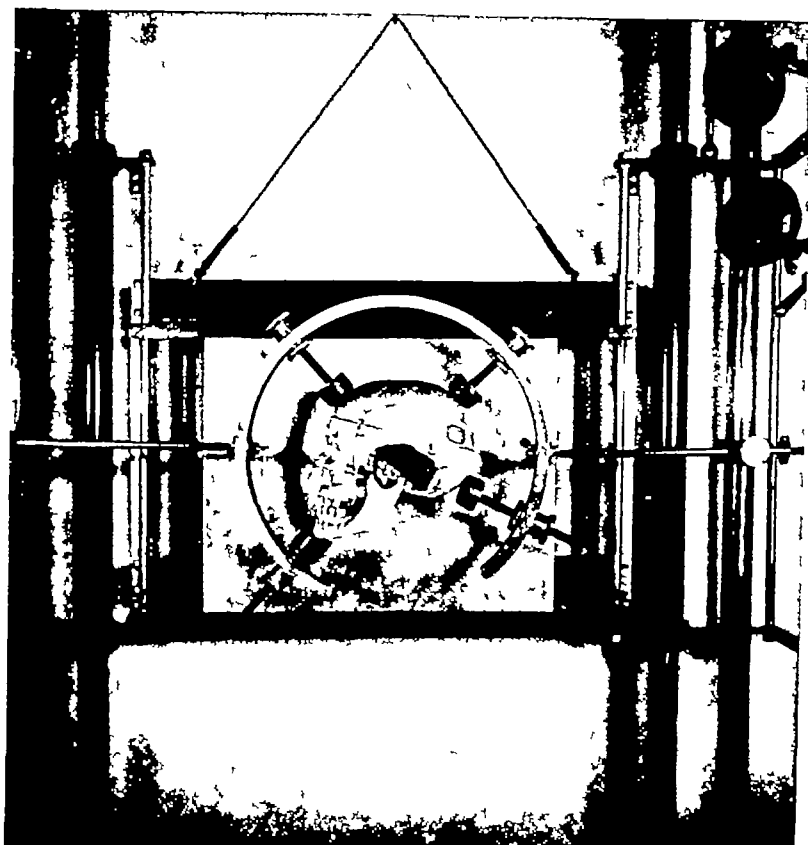


Fig 5

Lumbar lordosis is flattened out by flexing and abducting the legs at the hip-joints, as in the lithotomy position (7). The center beam has to be vertically on the cassette. I do not approve of the much-used technic of taking a film of the sacro-iliac region by tilting the tube or the center beam to 45 degrees. By this means we may obtain a good view of the sacro-iliac joints, but we get too much enlargement and distortion.

(4) Next, the oblique views of the lumbar spine are taken with the aim of showing all the small intervertebral facets of the lumbosacral region. For this purpose,

shown with the patient lying on either side, with his body tilting 20 degrees forward from the vertical lateral position.

In order to facilitate the correct centering of the X-ray tube for the special views of the lumbosacral region and the intervertebral joints, which are all taken with the patient lying down and at a film-focus distance of one meter, I have constructed a new *center beam index*, which carries a scale of the film-focus distance, and which may be attached to or removed from the tube with one movement of the hand (Figs 3 and 6).

Before entering into the discussion of

or injuries to the intervertebral discs and minute compression fractures of vertebral bodies, by the method of determination of the axis introduced by Jaeger. The following technic is used

a kyphoscoliosis, always show a well defined curve with no angulation, while a wedge-shaped vertebra caused by a recent compression fracture, no matter how mild, will always show a deviation of the axis,

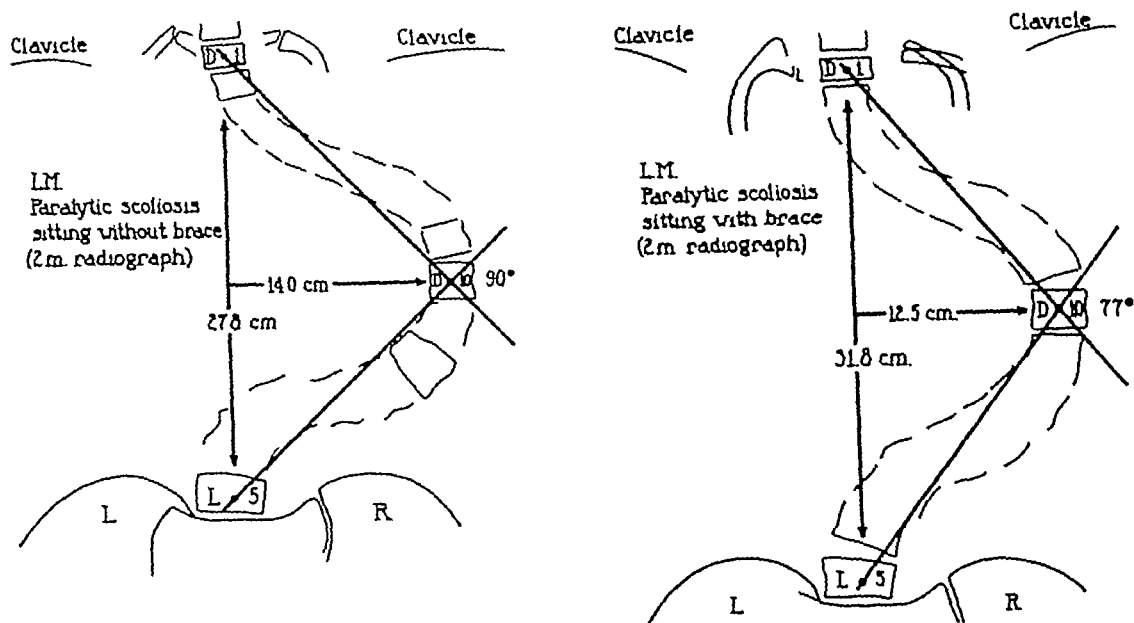


Fig 10

From the long-distance anteroposterior and lateral roentgenographs of the spine, a tracing is made outlining the vertebral bodies in each plane. The longitudinal axis of each vertebral body is constructed by drawing a line connecting the center of its cranial and caudal contours. The axes so obtained are connected, giving the total curve of the vertebral column, anteroposterior and lateral views (Fig 9). Whenever this line forms an angle instead of a well defined curve, we may expect the site of some recent pathology. Jaeger has shown that by this method it is possible not only to discover the localization of a fracture of an intervertebral facet, of a pedicle, or a subluxation of a cervical vertebra, but also to discriminate between a recent injury to the spine and old changes and to follow the reconstruction of the curve in the course of healing of a fracture.

Deformities of the spine as, for instance,

forming an angle. Wherever the determination of the axis in the tracing of the long-distance roentgenograph of the spine shows angulation, small cone views of this section are taken, including oblique views, with the result that in many cases a fracture or subluxation is found. It is obvious that this technic for determining a recent injury to the spine as compared with an old deformity is of special value in medico-legal cases. The author has frequently used this method in his capacity as Medical Referee for State Compensation and insurance companies.

In the treatment of scoliosis the importance of the analysis of the spine under weight-bearing, with the patient standing, is more and more recognized and generally used, and a vertical Potter-Bucky diaphragm is usually employed for this purpose. The long-distance method has the advantage of eliminating the distortion

sible only if the roentgenologist or x-ray technician is well informed as to the condition of the patient and the special question that needs to be answered by the radiogram. Close co-operation between the roentgenologist and the physician in charge of the case may frequently limit

bosacral region and the two 45 degree oblique views usually give all the information required.

The two-meter long-distance view of the spine with the patient in a vertical position affords a number of conspicuous advantages. As we have already mentioned, the so-called "compensating effect" of the long film-focus distance in the large section of the spine, depicted on one 14 X 17-inch film, gives at a glance a good survey of the major part of the column. It makes variations in the number and size of the vertebrae and a difference in structure and calcium content more easily perceptible. The favorable relation between film-object and object-focus distances does away with most of the distortion and gives all the structural details obtainable only otherwise in cone views of small sections of the spine.

In cases of suspected fracture of a vertebra, clinical examination is not always successful because of the fact that the pain is frequently referred to lower parts of the spine. Long-distance views will often prevent the overlooking of a fracture of a dorsal vertebra when the pain is localized in the lumbosacral region. In re-examination of injuries to the spine, I have found on several occasions a fracture of the tenth dorsal vertebra, and even of the twelfth dorsal, which had been overlooked for many weeks because the x-ray examination had been limited to the lumbar spine.

In injuries to the cervical spine it is difficult to obtain satisfactory lateral roentgenographs in the region of the lower cervical or the upper dorsal vertebrae. In these cases the long-distance view of the cervical spine has given us the best results (Fig 7), for instance, in a fracture of the spinous process of the seventh cervical or the first dorsal vertebrae, or in a fracture dislocation of the sixth and seventh cervical vertebrae (Fig 8).

One of the great advantages of long-distance roentgenography of the spine is the lack of distortion, which makes it possible to discover fractures of the intervertebral facets and the pedicles or neural arches,

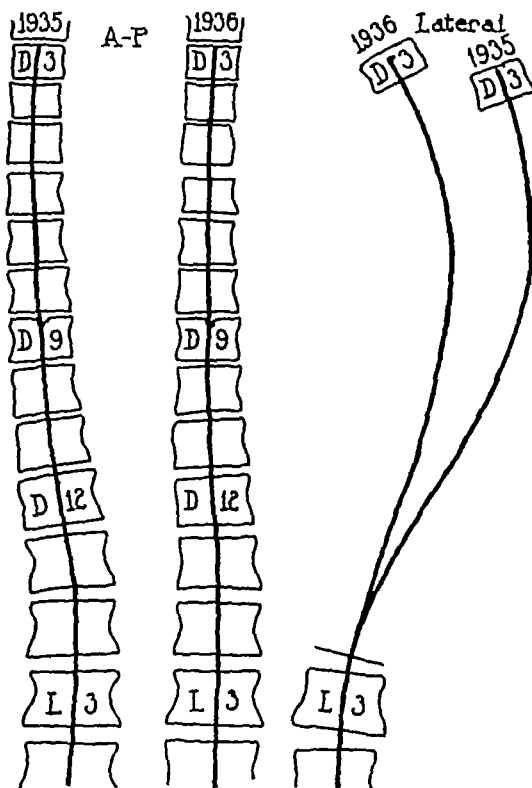


Fig 9

the number of x-rays that must be taken. While a complete analysis of the spine would necessarily consist of the nine standard exposures listed above, such a complete study may be dispensed with in many cases, in which the clinical diagnosis is not in doubt or in which the pathology is well localized. For instance, in the treatment of scoliosis, the anteroposterior long-distance view will frequently suffice to determine the type of brace to be applied and to check up on the efficiency of a spinal brace already in use. Or in the case of well defined lumbosacral arthritis, the special anteroposterior view of the lum-

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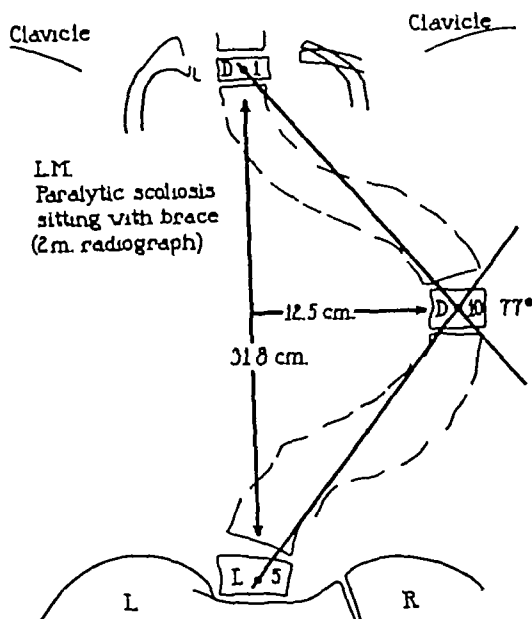
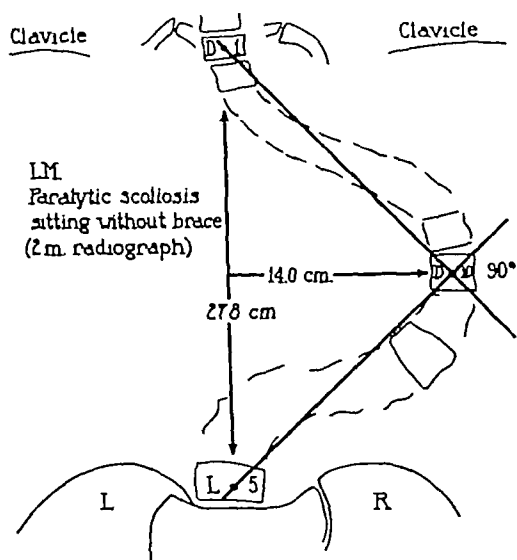


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which is so confusing in the evaluation of these exposures

The arrangement of the long-distance view of the spine described above facilitates the repetition of check-up x-rays

roentgenographs of the spine are used (Fig 10)

There is little to add in recommendation of the technic described for the anteroposterior view of the lumbosacral and



Fig 11

under identical conditions. Determination of the curvature by means of tracing the axes of the vertebral bodies is more accurate than other methods of measuring the angle of a scoliosis. We gain a valuable criterion for the evaluation of various treatments, which is essential to form an opinion based on facts in the discussion of operative *versus* conservative treatment of scoliosis.

In the conservative treatment of scoliosis and other spinal conditions, this method may be employed to great advantage to control the construction and fitting of spinal braces. If the method introduced by Ferguson (1) is used, it will be more accurate if tracings of long-distance

sacro-iliac region with the patient in the lithotomy position. This is, to my mind, the only way of obtaining an undistorted view of the fifth lumbar intervertebral disc and the details of the lumbosacral junction.

Deformities of this region, *viz*, narrowing of the intervertebral discs, large osteophytes, hemisacralization, or complete sacralization of the fifth lumbar vertebra, and so on, are, in our experience, of minor importance, and are rarely a satisfactory explanation for lower back pain or a sciatica. Arthrosis and arthritis of the small intervertebral facets are, however, of prime importance as a cause of lower back pain, and should therefore be carefully investigated in every case of this type.

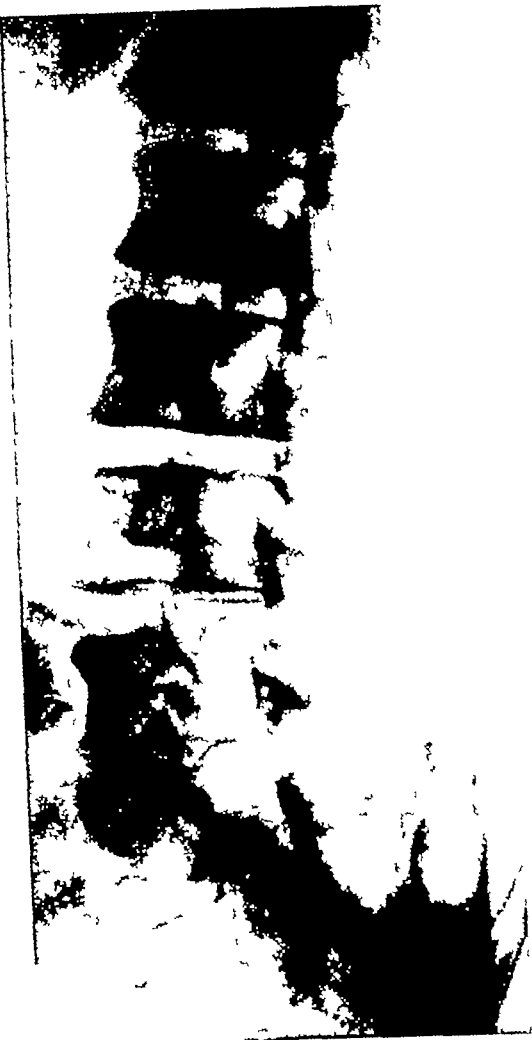


Fig 11 A

Furthermore, a joint formed between the transverse process of a sacralized fifth lumbar vertebra and the sacrum or ilium is frequently the site of a degenerative arthrosis. We may assume, as Max Lange has pointed out (5), that a gross deformity, as met with in spondylosis, very rarely causes an irritation of the nerve-roots by mechanical pressure, while on the other hand the relation of the posterior roots to the intervertebral joints is so close that an inflammation of these joints may readily spread to the nerve. Therefore, the study of the small intervertebral joints is essential. Due to the anatomical structure of the intervertebral joints in the various sections of the spine, we have to place



Fig 12

the patient in various positions in order to obtain an undistorted view right into the joint space. While individual variations may render this problem difficult sometimes, we have found that the 45-degree oblique position will show all the lumbar intervertebral joints, and the 20-degree tilted lateral view those of the dorsal region, in the average patient (Figs 11, 11-A, and 12).

From the illustrations shown, it is apparent that these views reveal not only the intervertebral facets, but also many details of the neural arch and the pedicles which are not otherwise clear. We have found that these oblique views are of such value in cases of spondylarthritis and spondylarthrosis that they deserve to be included in the routine examination, even in preference to the long-distance view of the entire spine.

SUMMARY

"Roentgen analysis" of the spine represents a complete radiological study of the spine as an entity, as well as of its individ-

ual elements, with special reference to the small intervertebral joints and the complicated structure of the lumbosacral region.

The x-ray technic described in this paper has proved so successful in our hands and its application so simple that it may be used as a standardized routine procedure in every x-ray department.

Special attention has been given to teleradiography of the spine with the patient standing or sitting. The long film-focus distance of two meters makes possible a survey of the major section of the spine on one 14 × 17 inch film, the "compensating effect" gives a well defined picture of the structural details in almost all sections of the spine, the freedom from distortion permits a method of determination of the axes of the vertebral bodies and the entire spinal column, which is of im-

portance for the recognition of minor fractures and the diagnosis and treatment of deformities.

A telescope for teleradiography and a new center-beam-index are introduced.

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CARCINOMA OF THE OVARY

RESULTS SECURED BY RADIATION THERAPY¹

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CARCINOMA of the ovary being one of the most radiosensitive epithelial tumors, it is highly important to know what results are obtained by radiation treatment of this disease. While practically every patient in the series here presented had some surgical procedure—ranging from laparotomy and biopsy to attempted excision—it was not felt that the probability of cure was good in any of the cases if surgery alone was used, in many of them, since the primary tumor was not removed, the only benefit traceable to surgery was that a definite diagnosis was made available. Consequently, we feel that the principal treatment in these patients was with radiation. This is made more explicit when we state that of the 15 patients now living (for various periods), eight had definite metastases at the time of the first irradiation, while the other seven had none mentioned in the available records (but it is not known with certainty that they did not have metastases). Exact evaluation of the original clinical condition is now impossible, because of the defects in the earlier records. However, most of the patients had metastases, often peritoneal implants but occasionally distant, and several were moribund at the time of first treatment.

The age incidence (Fig 1) shows its peak in the sixth decade, nor is it greatly changed by correcting for the distribution of the different age groups in the population. The disease is then one of late middle life, with the peak incidence just after the time of the average woman's menopause. This occurrence of the peak in relation to the menopausal age is perhaps fortuitous,

because a fair number of the cases occurred in youth or advanced age.

As diagnosis was made on the microscopic appearance of material obtained at operation or necropsy, the accuracy of our

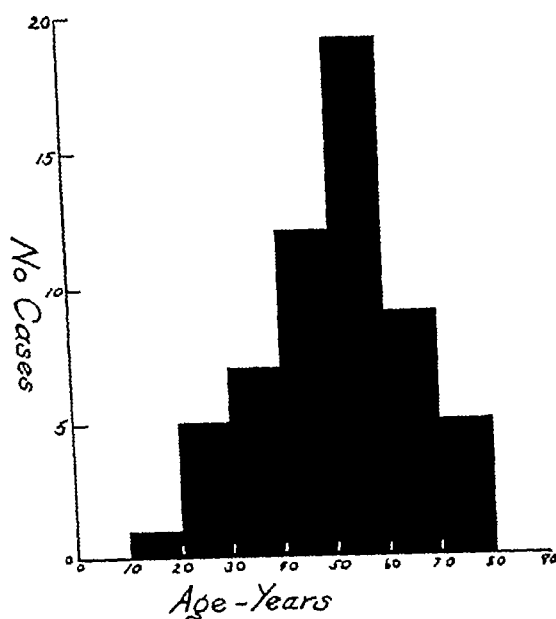


Fig 1 Age distribution of cases reported in this paper

diagnosis can be no better than the accuracy with which a pathologist is able to distinguish carcinoma from benign ovarian lesions. This is, unfortunately, a disputed point. It is, therefore, important to remember the weakness of this criterion. The distribution of the various pathologic types can be described only in the most elementary way (Table I), as the small number of cases and the incompleteness of the early records make proper study almost impossible. It is worth noting that in the cystic carcinomas the papillomatous outnumbered the pseudomucinous in those

¹ Presented at the meeting of the Radiological Society of Minnesota in St. Paul March 28 1930

least were in fair condition. Moreover, those who had multiple heavy courses did better than those who had only a single

the six still living who have passed the five-year mark, one has a persistent mass in the cul-de-sac which, while static, rep-

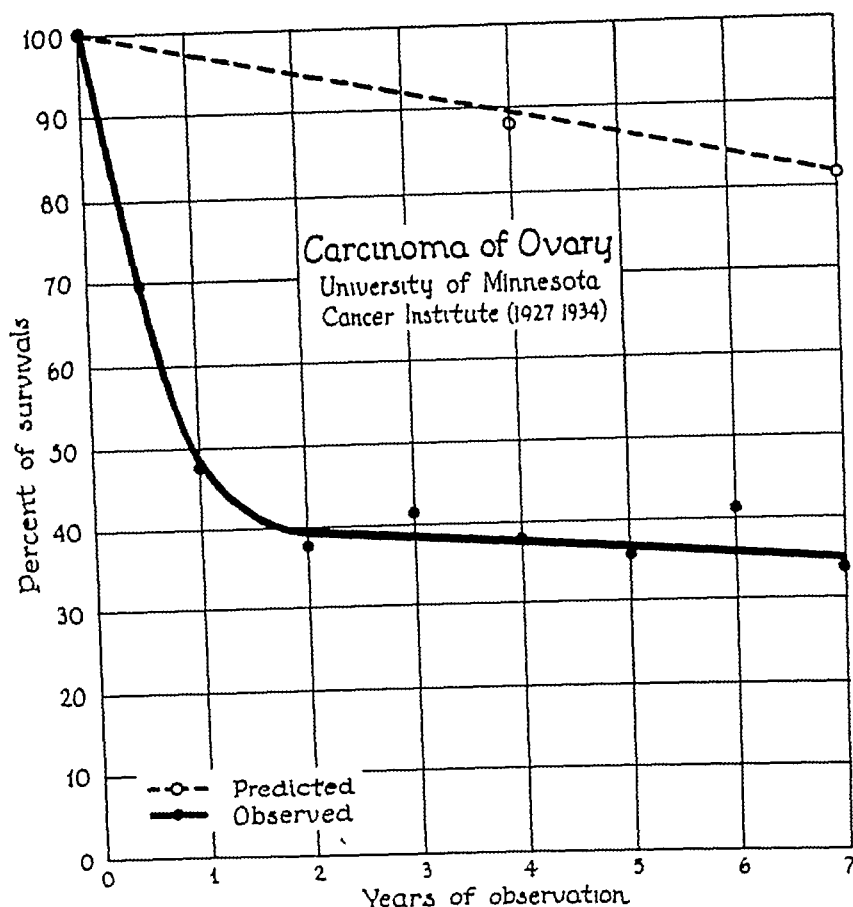


Fig 2 Survival in carcinoma of the ovary. The upper curve (dashed) shows the average probability of survival normal for such an age group. The lower (solid) curve shows the observed survival. Note the flattening of the curve after four years which shows that patients are apt to stay well if they pass this time. For method of deriving curve see 'An Improved Method for the Treatment of Cancer Statistics' by L. G. Jacobs, *RADIOLOGY*, October, 1936, 27, pp. 468-473.

heavy course. (As a matter of fact, two courses were regularly advised, but not always accepted.) The obvious explanation for this observation, that large amounts of x-ray are needed for cure, is the only one which appears to bear critical analysis.

Looking at the series as a whole, we see that there is a fair salvage rate (Fig 2) for a five-year period, about 35 per cent. Since the trend of the curve is flat, those who have survived over five years may be considered as probably cured, although of

resents a constant threat to life which will no doubt eventually materialize. Those surviving over four years and now living were by no means all "favorable" cases at the beginning of treatment. Two had extensive peritoneal metastasis, in one case with invasion of the bladder. Four more patients had, on beginning their course of radiation, definite recurrences after a previous operation. One patient, surviving two years and still in good condition, had only a biopsy done, as the tumor had already involved the surround-

TABLE IV²

No	Age	Date Onset	Date	Diagnosis	First Treat Date Sort	Second Treat Date Sort	Thrd Treat Date Sort	Fourth Treat Date Sort	Fifth Treat Date Sort	Date Death	Diagnosis Notes
256	36	12-1-26	5-1-27	5-1-27	5-1-27 S*	6-24-27 X*	9-27-27 X*	2-24-28 X*	9-21-28 X*	A and W	Gelatinous adenoma
276	65	5-15-27	6-15-27	6-15-27	6-15-27 S	7-21-27 X*	12-9-27 X*			5-9-29	Cystic ca c metastases
504	38	3-1-28	5-1-28	5-1-28	5-1-28 S*	6-13-28 X*	9-21-28 X*	10-30-29 X*		A and W	Papillary ca c metastases
548	56	1-1-26	1-1-26	1-1-26	1-1-26 S*	6-1-28 S*	8-4-28 X*			A and W	Colloid ca c metastases
604	40	3-1-26	5-7-28	5-7-28	5-9-28 S*	11-2-28 X*	6-1-29 S*	9-17-29 X*		8-2-34	Cystic adenoma
629	44	1-1-27	11-1-28	11-1-28	11-1-28 S*	12-10-28 X*	3-20-29 X*			6-26-29	Adenoma (c diabetes and myocarditis)
795	33	?	5-1-29	5-1-29	5-1-29 S*	7-2-29 X*	10-1-29 X*			12-17-29	Cystic ca c metastases
892	53	8-1-29	8-21-29	8-21-29	8-21-29 S*	10-4-29 X*	3-21-30 X*			11-11-30	Cystic ca
1230	72	1-1-25	1-1-26	1-1-26	1-1-26 S*	9-10-30 X*	4-22-32 X*			4-3-35	Ca type not stated
1,340	37	1-1-29	9-1-30	9-1-30	9-1-30 S*	12-29-30 X*				A and W	Cystic papillary ca
1,407	61	12-1-30	2-14-31	2-14-31	2-14-31 S*	3-11-31 X*	6-30-31 X*			1-2-32	Solid papillary ca c metas
1,430	70	?	12-1-29	12-1-29	12-1-29 S*	3-30-31 X*				5-5-31	Ca type not stated
1,505	58	9-1-30	4-30-31	4-30-31	4-30-31 S*	5-20-31 X*				11-2-31	Cystic ca c metastases
1,529	56	3-1-31	5-21-31	5-21-31	5-21-31 S*	6-4-31 X*	9-18-31 X*	1-29-32 X*	10-25-32 X*	2-1-33	Solid papillary adenoma
1,588	43	?	6-18-31	6-18-31	6-18-31 S*	7-29-31 X*				A and W	Pseudomucinous cystic ca
1,600	80	6-1-30	10-1-30	10-1-30	10-1-30 S*	8-5-31 X*				9-3-31	Ca type not stated
1,634	24	6-1-31	6-6-31	6-6-31	6-6-31 S*	8-31-31 X*				11-25-35	Cystadenoma
1,725	50	1-1-30	6-1-30	6-1-30	6-1-30 S*	10-28-31 X*				AcP	Cystadenoma
1,828	49	12-1-30	10-15-31	10-15-31	10-15-31 S*	1-11-32 X*				9-16-33	Papillary cystadenoma
1,995	40	many yrs	3-1-32	3-1-32	3-1-32 S*	4-10-32 X*				A and W	Solid ca
2,107	45	1-1-30	?	?	6-20-32 X*					4-22-33	Cystadenoma, ulcerated through umbilicus
2,110	41	12-1-30	1-1-31	1-1-31	1-1-31 S	6-22-32 X*				6-30-32	Cystic ca (ruptured into bowel)
2,161	30	1-2-30	6-2-30	6-2-30	6-2-30 S*	6-2-30 S*	8-1-32 X*	2-27-33 X*	12-2-33 X*	AcP	Cystic ca, ascites
2,173	47	5-1-31	6-1-32	6-1-32	7-1-32 S*	8-10-32 X*				A and W	Pseudomucinous cystic ca
2,223	57	1-1-31	7-20-32	7-20-32	7-21-32 S*	9-14-32 X*	2-20-33 X*			AcP	Degenerating ca, type not stated
2,265	68	1-1-10	1-1-10	1-1-10	1-1-10 S*	1-1-27 S*	10-12-32 S*	10-25-32 S*	11-5-32 X*	A and W	Cystic ca
2,331	62	9-1-30	10-1-30	10-1-30	10-1-30 S*	10-24-32 X*	3-21-33 X*			7-30-34	Cystic ca, cardiac dc compensation
2,367	59	5-1-32	8-1-32	8-1-32	8-1-32 S*	12-28-32 X*	12-30-32 S			1-9-33	Cystic ca patient too ill to complete x ray course
2,376	43	3-1-32	11-1-32	11-1-32	11-1-32 S*	1-4-33 X*				3-22-33	Adenoma
2,380	40	6-1-32	11-1-32	11-1-32	7-1-32 S*	11-1-32 S*	1-6-33 X*	3-27-33 X*	6-20-33 X*	9-4-33	Adenoma
2,384	73	12-1-32	1-1-33	1-1-33	1-1-33 X*					5-10-35	Ca type not stated
2,501	76	3-30-33	4-6-33	4-6-33	4-6-33 S*	5-12-33 X*				2-20-34	Cystic ca c metastases
2,574	51	10-1-32	5-6-33	5-6-33	5-6-33 S*	5-18-33 X*				A and W	Papillary cystic ca had also ca breast c S* X*

No	Age	Date Onset	Date	First Treat	Second Treat	Third Treat	Fourth Treat	Fifth Treat	Date	Diagnosis Notes
				Date	Date	Date	Date	Date		
2600	58	3-2-33	5-1-33	S*	6-6-33 X*	1-17-34 X*	6-15-33 X*		7-28-34	Cystic ca Grade IV
2610	22	4-2-30	7-8-30	S'	7-8-30 S*	5-18-33 S*			A and W	Cystic ca
2630	56	2-2-33	6-9-33	S*	6-24-33 X*				7-9-33	Nodular cystic ca c metas
2645	62	1-2-33	6-23-33	S*	7-6-33 X*	7-11-33 R			8-21-33	Cystic ca c metastases, (peritonitis secondary to treatment?)
2885	53	9-2-33	9-2-33	X'					11-21-33	Cystic ca
2918	56	2-2-32	2-2-32	S*	12-6-33 X*	5-11-34 X*			2-25-35	Cystadenoc c metastases
2988	26	12-2-33	1-2-34	S	1-9-34 X*				4-2-34	Solid ca c metastases
3021	55	9-2-33	9-11-33	S*	9-2-33 X*	1-29-34 X*	2-13-35 X*		A and W	Ca type not stated
3039	73	2-2-34	2-8-34	X*					3-6-34	Ca clinical diag, no post
3133	50	11-2-33	1-26-34	S*	4-5-34 X*				11-13-34	Ca type not stated
3157	44	10-2-34	4-17-34	X*					11-13-34	Ca clinical diag, no post
3159	55	1-2-34	4-11-34	X*					9-22-34	Solid ca
3160	61	1-2-34	5-3-34	X*	?	S'			6-3-34	Ca (cells in tap fluid)
3203	54	4-1-34	5-9-34	X*					2-2-35	Cystic ca with bone metas
3230	20	1-2-34	5-2-34	S*	6-1-34 X*				A and W	Cystadenoc
3284	60	6-2-33	2-23-34	S*	6-20-34 X*				11-25-34	Cystic ca, bronchopneu- monia
3270	67	1-2-33	6-8-34	S*	6-10-34 X*				3-4-35	Serous cystadenoc
3340	38	8-2-33	7-2-34	S*	8-6-34 X'				8-20-34	Ca type not stated patient too ill to finish course
3409	42	2-2-20	2-2-30	S*	9-4-34 S*	9-15-34 X*	4-4-35 S*	5-8-35 X*	A and W	Cystic ca, severe arthritis
413	?	Sx yrs	12-12-27	S*	2-1-28 X*				5-22-28	Cystic ca
881	58	9-2-28	5-2-29	S	9-23-29 X*				12-27-29	Ca c peritoneal metastases
1052	39	12-2-28	1-25-29	S*	3-31-30 X*	8-8-30 X*			10-2-30	Cystadenoc c metastases
1171	60	6-2-20	1-2-30	S	7-11-30 X*				10-14-30	Solid ca
1188	51	4-20-30	6-12-30	S*	7-30-30 X*				10-24-30	Solid ca
1149	64	12-2-30	?	R?	3-30-31 X'				4-15-31	Ca c peritoneal metastases
1925	48	9-2-27	12-2-27	S*	3-10-32 X*				4-19-32	Cystic ca
1512	23	1-2-27	10-2-29	S*	8-7-30 S*	9-2-30 X	5-19-30 S	5-25-31 X*	5-25-32	Spindle-cell sarcoma
3085	26	8-2-33	8-2-33	S*	3-7-34 X*				5-12-34	Fibrosarcoma c cystic mass
2487	47	9-2-32	3-21-33	S*	3-30-30 X*				A and W	Granulosa cell tumor
1922	46	5-2-31	9-18-31	S*	1-8-32 X*	3-30-32 X*			8-18-32	Benign adenoma (?)
1954	50	2-2-20	2-2-20	S*	3-20-32 X*	3-4-33 X*			AcP	Benign cyst c transplants

* Key to Symbols in Table IV S*—Lapsoy only S'—tapping only S—surgical procedure type unknown, X*—large dose x ray X'—medium dose x ray X'—small dose x ray X—unknown dose x ray, R—radium (given elsewhere) A and W—alive and well, AcP—alive with persistence or recurrence, c—with

TABLE IV²

No	Age	Date Onset	Date	Diagnosis	First Treat Date	Sort	Second Treat Date	Sort	Third Treat Date	Sort	Fourth Treat Date	Sort	Fifth Treat Date	Sort	Date Death	Diagnosis Notes
256	30	12-?-26	5-?-27	5-?-27	5-?-27	S*	6-24-27	X*	9-27-27	X*	2-24-28	X*	9-21-28	X*	A and W	Gelatinous adenoca
276	65	5-15-27	6-15-27	6-15-27	6-15-27	S	7-21-27	X*	12-?-27	X*					5-?-29	Cystic ca c metastases
504	38	3-?-28	5-?-28	5-?-28	5-?-28	S*	6-13-28	X*	9-21-28	X*	10-30-29	X*			A and W	Papillary ca c metastases
548	56	?-?-26	?-?-26	?-?-26	?-?-26	S*	6-?-28	S*	8-4-28	X*					A and W	Colloid ca c metastases
604	49	3-?-26	5-7-28	5-9-28	5-9-28	S*	11-2-28	X*	6-?-29	S*	9-17-29	X*			8-2-34	Cystic adenoca
629	44	?-?-27	11-?-28	11-?-28	11-?-28	S*	12-10-28	X*	3-20-29	X*					6-26-29	Adenoca (c diabetes and myocarditis)
795	33	?	5-?-29	5-?-29	5-?-29	S*	7-2-29	X*	10-1-29	X*					12-17-29	Cystic ca c metastases
892	53	8-?-29	8-21-29	8-21-29	8-21-29	S*	10-4-29	X*	3-21-30	X*					11-11-30	Cystic ca
1230	72	?-?-25	?-?-26	?-?-26	?-?-26	S*	9-10-30	X*	4-22-32	X*					4-3-35	Ca type not stated
1340	37	?-?-29	9-?-30	9-?-30	9-?-30	S*	12-29-30	X*							A and W	Cystic papillary ca
1407	61	12-?-30	2-14-31	2-14-31	2-14-31	S*	3-11-31	X*	6-30-31	X*					1-2-32	Solid papillary ca c metas
1430	70	?	12-?-29	12-?-29	12-?-29	S*	3-30-31	X*							5-5-31	Ca type not stated
1505	58	9-?-30	4-30-31	4-30-31	4-30-31	S*	5-20-31	X*	9-18-31	X*	1-29-32	X*	10-25-32	X*	11-2-31	Cystic ca c metastases
1520	56	3-?-31	5-21-31	5-21-31	5-21-31	S*	6-4-31	X*							2-?-33	Solid papillary adenoca
1588	43	?	6-18-31	6-18-31	6-18-31	S*	7-29-31	X*							A and W	Pseudomucous cystic ca
1600	80	6-?-30	10-?-30	10-?-30	10-?-30	S*	8-5-31	X*							9-3-31	Ca type not stated
1634	24	6-?-31	6-6-31	6-6-31	6-6-31	S*	8-31-31	X*							11-25-35	Cystadenoca
1725	50	?-?-30	6-?-30	6-?-30	6-?-30	S*	10-28-31	X*							AcP	Cystadenoca
1828	49	12-?-30	10-15-31	10-15-31	10-15-31	S*	1-11-32	X*							9-16-33	Papillary cystadenoca
1895	40	many yrs	3-1-32	3-1-32	3-1-32	S*	4-10-32	X*							A and W	Solid ca
2107	45	?-?-30	?	?	0-20-32	X*									4-22-33	Cystadenoca, ulcerated through umbilicus
2110	41	12-?-30	1-?-31	1-?-31	1-?-31	S	6-22-32	X*							6-30-32	Cystic ca (ruptured into bowel)
2161	30	1-2-30	6-2-30	6-2-30	6-2-30	S*	6-2-30	S*	8-1-32	X*	2-27-33	X*	12-2-33	X*	AcP	Cystic ca, ascites
2173	47	5-?-31	6-?-32	6-?-32	7-?-32	S*	8-10-32	X*							A and W	Pseudomucous cystic ca
2223	57	?-?-31	7-20-32	7-20-32	7-21-32	S*	9-14-32	X*	2-20-33	X*					AcP	Degenerating ca, type not stated
2265	68	?-?-10	?-?-10	?-?-10	?-?-10	S*	?-?-27	S*	10-12-32	S*	10-25-32	S*	11-5-32	X*	A and W	Cystic ca
2331	62	9-?-30	10-?-30	10-?-30	10-?-30	S*	10-24-32	X*	3-21-33	X*					7-30-34	Cystic ca, cardiac decompensation
2307	59	5-?-32	8-?-32	8-?-32	8-?-32	S*	12-28-32	X*	12-30-32	S					1-9-33	Cystic ca, patient too ill to complete x ray course
2376	43	3-?-32	11-?-32	11-?-32	11-?-32	S*	1-4-33	X*							3-22-33	Adenoca
2380	30	6-?-32	11-?-32	7-?-32	7-?-32	S*	11-?-32	S*							9-4-33	Adenoca
2384	73	12-?-32	1-?-33	1-?-33	1-?-33	X*			1-6-33	X*	3-27-33	X*	6-20-33	X*	5-10-35	Ca type not stated
2561	76	3-30-33	4-0-33	4-0-33	4-0-33	S*	5-12-33	X*							2-20-34	Cystic ca c metastases
2574	51	10-?-32	5-0-33	5-0-33	5-0-33	S*	5-18-33	X*							A and W	Papillary cystic ca, had also ca breast c S* X*

THE TREATMENT OF HYPOTONIC MEGACOLON BY ADMINISTRATION OF PANCREATIC TISSUE EXTRACT

By ROBERT J REEVES, M D , and EDWARD K HARRISON, M D ,
Durham, North Carolina

From the Roentgen-ray Department and the Department of Medicine, Duke University Hospital

SINCE Hirschsprung described the congenital megacolon in 1886, much has been written concerning treatment, both surgically and by the use of various drugs for stimulating the parasympathetics and producing peristalsis

Megacolon may be classified as congenital and acquired. The congenital type, as described by Hirschsprung, is associated with hypertrophy and the thickening of all the layers of the colon wall. The acquired type is subdivided into those produced by mechanical obstruction and by idiopathic dilatation. It is this latter group with which we wish to deal.

Sheldon and Kern (1) attempted the use of parathormone, but their conclusions do not appear to be lasting in effect. It was their opinion that the patients might have a low grade chronic parathyroid deficiency. Our studies have not borne this out.

Bonar (2) believes the etiology of idiopathic megacolon to be neuromuscular, due to failure of the pelvi-rectal flexure to relax with oncoming peristaltic waves. By means of rectal injections of a saturated solution of magnesium sulphate, he found the action to be local, apparently due to neuromuscular irritation and relaxation of the musculature.

Craven and McCrea (3) studied the effect of tissue extract and other vascular depressor substances, and Craven (4), in 1934, reported two cases of megacolon in children treated by means of pancreatic tissue extract. Her theory was that pancreatic extract is parasympathetic in action. In her work on direct observation of the intestines of the guinea pig, also on isolated strips of intestine, there was immediate contraction. After this contraction has been maintained for a short time, it becomes rhythmical. Some of the other

parasympathetic drugs—atropine, thyroxin, parathormone, and magnesium sulphate—produced contraction but did not increase the rhythm. This probably explains why a short time after the drug is discontinued, the intestine fails to respond.

PREPARATION USED

The extract used is that of Sharp and Dohme, No 568, as prepared in collaboration with Dr Joseph Wolfe (5). It is a product of pancreatic tissue extracted with acid alcohol. After precipitation of insulin, the precipitate is purified and physiologically standardized by its ability to neutralize the pressor action of epinephrine on anesthetized dogs. The solution is then adjusted to contain ten units per c c. The unit value is defined from the epinephrine neutralizing action: one unit equals one gamma of epinephrine. Therefore, 1 c c will neutralize 0.01 mg of epinephrine.

DOSAGE

The dosage used in the treatment of the atonic colon varies from 1 to 5 c c, depending on the severity of the condition and the response of the patient. The usual daily dose is 3 c c, which seems to give the maximal effect. Wolfe states, "We have administered more than 5,000 injections and there has never been any untoward local or general reaction, save a slight burning at the time of injection. No chills, fever, or other systemic reactions have been noted."

CASE REPORTS

Case 1. A married female, aged 28, was admitted March 17, 1934, with a history of increasing constipation of seven years' duration. Following operation for appendicitis, she noticed a gradually increasing

ing region so extensively as to render removal impossible

Since the normally expected death incidence in a group such as this is rather high, about 13 per cent in five years, the actual cure rate may readily be as high as 35 per cent. The standard deviation of the cure rate is about 5 per cent, so that it is within the bounds of possibility that the true cure rate will fall between 20 per cent and 50 per cent, but hardly outside these values. Observe that we here mean the rate of those permanently cured, not the five-year cure rate.

Evaluation of the degree of palliation secured in those patients who died is not possible, but one can safely say that it is a very real amount. Several patients had from a few months to several years of normal or almost normal life before a recurrence finally led to invalidism and death, and even in cases not symptom-free vari-

ous degrees of improvement were noted, as a rule. Only a few advanced cases failed to receive any benefit from their treatment.

In conclusion, radiation will produce enough cures in carcinoma of the ovary, even advanced, to make it a decidedly justifiable procedure. The amount of radiation must be adequate, however, and repeated courses are probably advisable. The figures quoted suggest that there may be a slightly higher cure rate in this sensitive tumor than in some of the more resistant gynecological tumors.

Acknowledgments The clinical direction of these patients has been in the hands of the Department of Gynecology and Obstetrics, Prof. J. C. Litzenberg, head. We wish also gratefully to note the aid and advice of Dr. Litzenberg in the preparation of this paper.

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CASE REPORTS

Case 1. A married female, aged 28, was admitted March 17, 1934, with a history of increasing constipation of seven years' duration. Following operation for appendicitis, she noticed a gradually increasing

constipation which had become so severe that she resorted to daily enemas during the last year. The stools had been mixed

bowel movements for three days, then normal stools. The bowels have been regular until the present time, 1937.



Fig 1 Case 2 Dilated colon. No former treatment.

with considerable mucus, and occasionally small amounts of blood. The diet had been balanced and water intake adequate.

Physical Examination—Entirely negative. A proctoscopic examination showed normal mucosa. The lumen was quite large and dilated.

Laboratory Studies—Blood and urine examinations were negative. Stool examination disclosed nothing unusual. A barium enema showed the colon to be large and atonic with loss of haustral markings. The basal metabolic rate was -18 per cent.

Treatment—Tissue extract was given, 1 c c the first day, 2 c c the second, and 3 c c on the third day and daily, thereafter, for ten days.

Clinical Course—Normal bowel movements were obtained after the second injection and continued to improve. Pregnancy, with normal delivery, occurred on Jan 18, 1935. Bowel movements were still normal until the following April, one year after beginning treatment, when constipation recurred. The course of tissue extract was repeated. There were no



Fig 2 Case 2 The colon after tissue extract. The muscle tone has been greatly improved but is still moderately dilated.

Case 2 A white male, aged 3, with a history of constipation since birth, was admitted May 25, 1936. The stools though infrequent had been large and quite hard. The patient had been otherwise normal. Constipation had been worse during the past year, with as many as ten days elapsing between stools.

Physical Examination—The abdomen was markedly distended and fecal masses could be easily palpated.

Laboratory Studies—The blood, urine, and stools were negative. A barium enema disclosed a large atonic colon, probably congenital in origin (Fig 1).

Clinical Course—Pancreatic tissue extract was administered three times daily in 0.5 c c doses from May 27 to May 30. The distention was relieved and there was irregular spontaneous bowel movement. Roentgen-ray examination of the colon showed definite improvement in muscle tone (Fig 2).

Case 3 A white male, aged 64, was admitted to the hospital on March 9, 1936, with a history of dull epigastric pain of nine months' duration, the pain coming on regularly 30 minutes after eating. Oc-

asionally, he was nauseated and would vomit. Vomitus contained blood on several occasions. He had lost 40 pounds in the past six months. This was accompanied by a very obstinate constipation.

Case 4 A white male, aged 9, was admitted Feb. 22, 1933, complaining of severe constipation since birth. He usually went two to four days without a stool and had been given cathartics since birth. His

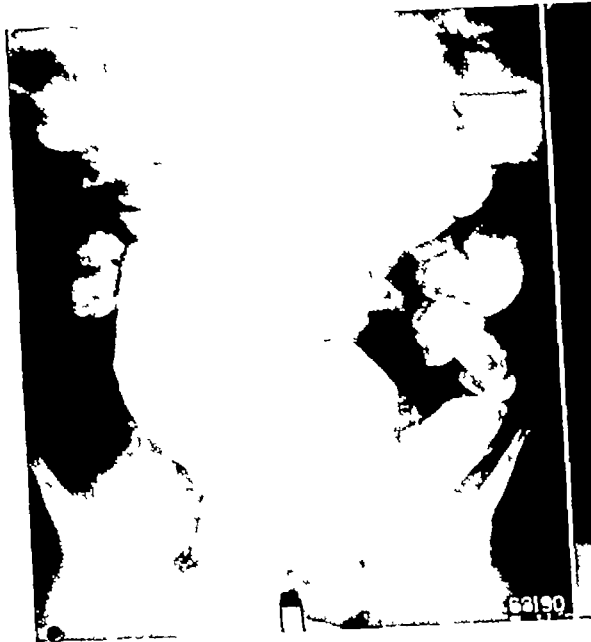


Fig 3

Fig 3 Case 3 Dilated colon. No former treatment.



Fig 4

Fig 4 Case 3 After tissue extract, showing rather marked improvement in muscle tone but still a certain degree of hypotonicity.

Physical Examination—The abdomen was greatly distended, but no masses could be made out and there was no tenderness.

Laboratory Studies—The blood showed considerable secondary anemia. The stools were positive for blood, the benzidene and guaiac tests being ++. Roentgen-ray examination disclosed a large carcinoma of the lower third of the esophagus. The esophageal hiatus was wide, and the fundus of the stomach herniated through it. The colon was large and atonic, with almost complete loss of muscle tone (Fig 3).

Clinical Course—Injections of intramuscular tissue extract were given twice daily in 0.5 c.c. doses for three days. There was a most striking improvement in muscle tone, accompanied by normal bowel movements (Fig 4).

The patient died of malignancy a few months later.

abdomen had been distended, apparently due to impacted fecal material.

Physical Examination—The patient's abdomen was very distended and a large mass could be easily palpated in the lower mid-portion. The veins over the abdominal wall were distended. Proctoscopic examination revealed a normal mucous membrane.

Laboratory Studies—The blood, urine, and stool examinations showed no pathology. A barium enema disclosed a large and atonic colon (Fig 5).

Diagnosis—Congenital megacolon.

Clinical Course—Intramuscular injections of tissue extract in 0.5 c.c. doses were given three times daily from March 2 to March 11, and in 1 c.c. doses three times daily from March 12 to March 24. During this period, the patient began to improve and to have from one to four stools

daily. He continued to improve for one year, when constipation again appeared. A barium enema at this time showed marked improvement in muscle tone, but a constriction was found at the

atonic colon, which had the appearance of Hirschsprung's disease.

Clinical Course—Intramuscular injections of pancreatic tissue extract were given in 1 c.c. doses, three times daily



Fig 5 Case 4 Dilated colon. No former treatment.

recto-sigmoid junction. This constriction was thought to be congenital or due to a band of adhesions. Because of the mechanical obstruction, no more tissue extract was given (Fig 6).

Case 5 A white male, aged 6, was brought into the out-patient clinic on June 27, 1933, with a history of occasional vomiting since birth. The vomiting, when it occurred, was projectile in character. The abdomen had gradually increased in size during the first week of life, until at the present time, it was greatly distended. His food was carefully watched, and he received a well balanced diet, but it was difficult to get him to eat it. The distention was accompanied by increasing constipation, which was relieved at frequent intervals by saline purges.

Physical Examination—The patient was markedly emaciated. His abdomen was very distended and the veins of the abdominal wall were quite dilated.

Laboratory Studies—The blood, urine, and stool examinations were entirely negative. Roentgen-ray examination of the colon showed a very large and completely



Fig 6 Case 4 Colon after series of tissue extract showing the congenital mechanical obstruction.

This was begun on June 28, 1933, and continued at intervals until Sept. 15, 1933. Marked improvement was noted for the first six months, but at the end of this time, there was a recurrence of the constipation. This, however, was not as severe as before.

Case 6 A white female, unmarried, age 19, was admitted to the hospital on Nov. 5, 1934, with a history of constipation over a period of four years. At times, she would go for a week without a bowel movement, and then resort to an enema. At one time, she was taking magnesium sulphate and calomel daily, and for the past 18 months had taken an enema every night. Eserine and thyroid extract had been tried, but did not produce beneficial results.

Physical Examination—The general physical examination did not reveal any pathology. A proctoscopic examination showed a dilated colon, having very little tone. However, the mucous membrane was normal.

Laboratory Studies—The blood, urine, and stool examinations were normal. Ba-

CASE REPORT

MEDIASTINAL ABSCESS COMPLICATING A RETROPHARYNGEAL ABSCESS

A CASE REPORT

By C C JONES, M D, SAMUEL BROWN M D
and ARCHIE FINE, M D, Cincinnati, Ohio

Retropharyngeal abscess is not a rare disease, but its mediastinal complication is only infrequently observed. Hence the reason for this case report.

A diagnosis of retropharyngeal abscess is, as a rule, not difficult. The clinical manifestations and the physical findings are of such a nature that they make the recognition of the disease relatively easy, but with mediastinal abscess, the findings are somewhat obscure. Since the introduction of the x-ray in the study of the soft structures of the neck and chest, the diagnosis of retropharyngeal and mediastinal abscess has been within the reach of everyone who makes use of it. In spite of the above fact, it is indeed surprising to find that the diagnosis is often missed. Greenwald and Messeloff (1), in a review of 55 cases, point out that the diagnosis was not made in many of the cases for as long as three weeks. Neither do they mention the use of x-ray, although this method of examination has been used with great success for a number of years by radiologists.

NORMAL AND MORBID ANATOMY (CLINICAL AND PHYSICAL FINDINGS)

The retropharyngeal space is only a potential one located between the posterior pharyngeal wall and the prevertebral layer of the cervical fascia. Above, it is limited by the base of the skull, and below it is continuous with the posterior mediastinal space by the prolongation of the deep layer of the cervical fascia. Its contents consist of lax areolar tissue in which are embedded eight to ten lymph nodes, which tend to retrogress after the age of three, so that in adults there may be only one or two nodes remaining. These glands receive afferent lymphatic vessels from the mucous membrane of the sinuses, Eustachian tubes, and nasopharyngeal region and are very frequently involved in upper respiratory infections. As a rule, they undergo resolution without breaking down, but every now and then suppuration may take place, producing an abscess in the retropharyngeal space which may extend downward behind the larynx and trachea into the posterior space. Caries of the cervical vertebrae, and injury and perforation of the pharynx by foreign bodies are other causes of abscess formation. The accumulation of pus

in the retropharyngeal space produces a bulging forward of the posterior wall of the pharynx which encroaches upon the lumen of the pharynx, larynx, and trachea, giving rise to symptoms of obstruction to breathing and swallowing. This mechanical interference is also accompanied by a rise of temperature and other manifestations of an acute pyogenic infection. The abscess may point anywhere in the neck and occasionally may rupture spontaneously.

Roentgenologically, the condition can be diagnosed before pronounced physical signs are present. In the case of the neck a lateral view is essential, the anteroposterior view not being of great help in the study of the soft structures. Under normal conditions a lateral view reveals a layer of soft tissues of varying thickness in front of the bodies of the cervical vertebrae. It is greater in infants and less in adults, but seldom exceeds 1.5 cm in thickness (2). In abscess formation the pharynx, and at times the larynx and trachea, are displaced forward, while the lumen of the pharynx is encroached upon. Occasionally one may note a foreign body embedded in the soft tissues of the neck, while less frequently a gas bubble may be recognized which is always pathognomonic. The possibility of tumors in this region must be kept in mind. The differential diagnosis must be made after considering the clinical and physical findings.

In the case of a mediastinal abscess an anteroposterior and a lateral view of the chest are necessary. A mediastinal abscess is usually found in the region of the superior and posterior mediastina, the shadow being often circular and extending to both sides of the spine. It may expand more to one side than to the other. In general, it resembles the shadow of a thymic tumor. However, in the lateral position of the chest the shadow, instead of being located anteriorly, as is the case with the latter, is found between the spine and trachea. The trachea is displaced forward through its entire course. In this position it is also possible to note the continuity of the abnormal shadow of the mediastinum with that of the retropharyngeal region.

The case to be reported is that of a white male (R. P.), age 1 year, admitted to the Jewish Hospital, Nov. 13, 1935, on the recommendation of Dr. W. Carmon, with a history of a cold and hacking cough for a week. The clinical diagnosis was that of pneumonia. The child frequently gagged and spit up blood-tinged mucus. Breathing was labored and he refused to eat, when food was given, it was vomited.

Examination disclosed a well developed infant, lying in bed with the head thrown back breathing with considerable difficulty. Respiration

After the x-ray study the infant was re-examined by one of us (C. C. J.), upon holding the patient up by the feet, a marked bulging



Fig 1

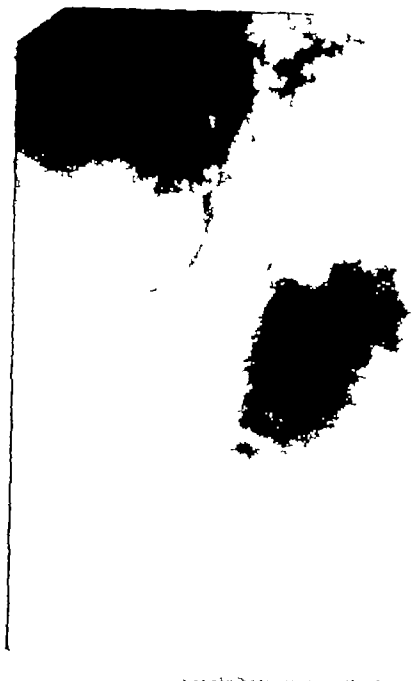


Fig 2

was of the obstructive type. Examination revealed no bulging or fluctuation on palpating back of the throat with the finger. Chest revealed possible lagging on the right side with slight diminution of breath sounds. Temperature was elevated, respiration and pulse accentuated.

An x-ray examination of the chest revealed, in the anterior view (Fig 1), a circumscribed homogeneous dense shadow in the region of the superior mediastinum and great blood vessels. The shadow extended more to the right than to the left side. The right upper lobe was somewhat congested. The rest of the lung was normal, as was the heart. The first impression was that of a thymic tumor. In order to determine the exact position of the tumor a lateral view of the neck and chest was made (Fig 2). No tumor in the region of the anterior mediastinum was revealed, thus excluding that possibility. The homogeneous shadow was found to be located between the spine and pharynx in the neck and between the spine and trachea in the chest, the pharynx, larynx, and trachea being displaced forward through their entire course. A diagnosis of a retropharyngeal and mediastinal abscess was made.

was noted in the posterior pharynx. It was opened, and free pus was obtained. The temperature gradually fell and when the child was re-examined by x-ray on the following day, there was a definite decrease in the size of the mediastinal abscess. It was thought at first that an external operation through the root of the neck was a necessary procedure to evacuate the pus from the posterior mediastinal space, but realizing the difficulties encountered in such an operation, it was decided to limit the drainage to the opening in the oral pharynx and, with the aid of gravity, enable the child to discharge the pus. This conservative procedure justified itself as proven by the favorable outcome of the case.

On Jan. 9, 1936, the child was re-admitted to the hospital because of high fever. An x-ray examination of the chest showed involvement of the right lung apparently due to a pneumonic process. The symptoms gradually subsided and the pulmonary lesion cleared up after several days. Re-examination on March 29, 1936, showed the lung-fields clear and the mediastinal and retropharyngeal regions free from any abnormal changes.

SUMMARY AND CONCLUSION

A year old boy with a retropharyngeal abscess complicated by a mediastinal abscess was diagnosed by the x-ray. Drainage established through the oral pharynx, assisted by gravity, proved to be sufficient to discharge all the pus, and the baby made a complete recovery.

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- (1) GREENWALD, H. M., and MESSELOFF, C. R. Retropharyngeal Abscess in Infants and Children. *Am Jour Med Sci*, 1929, 177, 767-778.
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RADIOLOGICAL SOCIETIES IN THE UNITED STATES

CALENDAR

MEETINGS FALLING BETWEEN THE DATES OF JUNE 15 AND JULY 31

July 15-17 Denver Radiological Club mid-summer meeting at Shirley-Savoy Hotel, Denver, Colo

Editor's note—Will secretaries of societies please co-operate with the Editor by supplying him with information for this page

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Affiliated with Philadelphia Roentgen Ray Society

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MAINE

See New England Roentgen Ray Society

MARYLAND

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MASSACHUSETTS

See New England Roentgen Ray Society

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first Thursday of each month from October to May, inclusive, at Wayne County Medical Society Bldg

MICHIGAN ASSOCIATION OF ROENTGENOLOGISTS *President*, J C Kenning, M D, 1536 David Whitney Bldg, Detroit, *Vice-president*, A W Chase, M D, 133 Toledo St, Adrin, *Secretary-treasurer*, C S Davenport, M D, 609 Carey St, Lansing

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MINNESOTA RADIOLOGICAL SOCIETY *President*, Walter H Ude, M D, 78 S 9th St, Minneapolis, *Vice-president*, Leo G Rigler, M D, University Hospitals, Minneapolis, *Secretary-treasurer*, Harry Weber, M D, 102 Second Ave, S W, Rochester Meetings quarterly

MISSOURI

THE KANSAS CITY RADIOLOGICAL SOCIETY *President*, L G Allen, M D, 907 N 7th St, Kansas City, Mo, *Secretary*, Ira H Lockwood, M D, 306 E 12th St, Kansas City, Mo Meetings last Thursday of each month
THE ST LOUIS SOCIETY OF RADIOLOGISTS *President*, Joseph C Peden, M D, 634 N Grand Blvd, *Secretary*, W K Mueller, M D, 607 N Grand Blvd Meetings fourth Wednesday of each month

NEBRASKA

NEBRASKA STATE RADIOLOGICAL SOCIETY *President*, Howard B Hunt, M D, 4740 Hickory St, Omaha, *Secretary*, D Arnold Dowell, M D, 117 S 17th St, Omaha Meetings first Wednesday of each month at 7 P M in Omaha or Lincoln

NEW ENGLAND ROENTGEN RAY SOCIETY

(Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, and Connecticut.) *President*, A E O Connell, M D, 390 Main St, Worcester, Mass, *Secretary*, E C Vogt, M D, 300 Longwood Ave, Boston Meetings third Friday of each month from October to May, inclusive, usually at Boston Medical Library

NEW HAMPSHIRE

See New England Roentgen Ray Society

NEW JERSEY

NEW JERSEY STATE RADIOLOGICAL SOCIETY *President* W W Maver, M D, 532 Bergen Ave, Jersey City, *Vice-president*, J D Tidaback, M D, 352 Springfield, Summit, *Secretary*, P S Avery, M D, Middlesex General Hospital, New Brunswick Meetings at Atlantic City at time of State Medical So-

ciety, and Midwinter in Newark as called by President

NORTH CAROLINA

RADIOLOGICAL SOCIETY OF NORTH CAROLINA *President*, Robert P Noble, M D, 127 W Hargett St, Raleigh, *Vice-president*, A L Daughtridge, M D, 144 Coast Line St, Rocky Mount, *Secretary-treasurer*, Major I Fleming, M D, 404 Falls Road, Rocky Mount Meetings with State meeting in May, and meeting in October

OHIO

RADIOLOGICAL SOCIETY OF THE ACADEMY OF MEDICINE (Cincinnati Roentgenologists) *President*, Harold G Reineke, M D, Cincinnati General Hospital, Cincinnati, *Secretary-treasurer*, George Benzing, M D, St Elizabeths Hospital, Covington, Ky Meetings third Tuesday of each month

PENNSYLVANIA

PENNSYLVANIA RADIOLOGICAL SOCIETY *President*, W E Reiley, M D, Clearfield, *First Vice-President*, Charles S Caldwell, M D, 520 S Aiken Ave, Pittsburgh, *Second Vice-president*, Louis A Milkman, M D, Medical Arts Bldg, Scranton, *Secretary-treasurer*, Lloyd E Wurster, M D, 416 Pine St, Williamsport, *President-elect*, Sydney J Hawley, M D, Geisinger Memorial Hospital, Danville Annual meeting, May 21-22, Erie

PHILADELPHIA ROENTGEN RAY SOCIETY *President*, Thomas P Laughery, M D, Germantown Hospital, *Vice-president*, Elwood E Downs, M D, Jeans Hospital, Fox Chase *Secretary*, Barton H Young, M D, Temple University Hospital, *Treasurer*, R Manges Smith, M D, Jefferson Hospital Meeting first Thursday of each month from October to May, Thompson Hall, College of Physicians, 19 S 22nd St, 8 15 P M

RHODE ISLAND

See New England Roentgen Ray Society

SOUTH CAROLINA

SOUTH CAROLINA X-RAY SOCIETY *President*, Robert B Taft, M D, 105 Rutledge Ave, Charleston, *Secretary-treasurer*, Hillver Rudisill, M D, Roper Hospital, Charleston Meetings in Charleston on first Thursday in November, also at time and place of South Carolina State Medical Association

SOUTH DAKOTA

Meets with Minnesota Radiological Society

TENNESSEE

MEMPHIS ROENTGEN CLUB Chairmanship

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EDITORIAL

LEON J. MENVILLE, M.D., *Editor*

HOWARD P. DOUB, M.D., *Associate Editor*

GROUP HOSPITALIZATION

Organized radiology has definitely gone on record opposing any group hospitalization plan which includes radiology or any other medical service in its contract. We have known for a long time that such a practice was not in accordance with the principle of the American Medical Association. We find in the *Journal of the American Medical Association*¹ of April 4, 1936, a very definite statement by the Bureau of Medical Economics of the American Medical Association which states:

"Group hospitalization by its very name connotes that the relationship is one of direct arrangements between hospitals and groups and that hospital care alone is the service bargained for. Group hospitalization, then, is a plan whereby a hospital or an association of hospitals contracts with classified groups of people to furnish hospital care when needed in return for the periodic payment or prepayment of a stipulated sum by each member of the group. A *bona fide* group hospitalization plan, as defined, should exclude all professional or medical services of physicians or surgeons, pathologists, roentgenologists, anesthetists, and special nurses. The control of the service provisions and membership funds should be in the hands of those who can render the service, namely, the hospitals or an association properly representative of the hospitals and the medical profession."

In spite of this we find local medical organizations continuing their endorsement of such group insurance plans. This indifferent attitude on the part of certain medical organizations must change, not to protect radiology but to save medicine. It may be that they will alter their position in this regard after reading the report of the Bureau of Medical Economics, in the May 1, 1937, issue of *Journal of the American Medical Association*, which because

of its importance to radiology, we herewith present in part to our readers.²

"In certain States the compensation laws permitted the formation of associations to provide medical and hospital care for employees entitled to compensation and authorized payroll deductions from employees. Such associations almost surreptitiously added medical care and hospitalization for non-compensable injuries and illnesses and brought a loosely constructed organization into the medical and hospital fields. In other States the laws permitted the expansion of medical services provided by employers to care for non-compensable as well as compensable conditions, but most State laws stipulated that employers alone should pay for compensation claims. To provide the medical and hospital services, employers expanded their industrial health services, used subsidized or company-owned hospitals, and formed contracts with physicians, hospitals, and medical and hospital benefit associations—generally with the expectation of lowering accident costs or of securing more favorable personnel relations with employees.

"Much dispute and ill feeling has arisen because of the failure to differentiate between industrial health services and medical service systems. Industrial health services are maintained entirely at the expense of the employer to fulfill his responsibility, sometimes as a 'self-insurer,' for industrial injuries. The objectives are to safeguard employees against accidents and to provide prompt medical supervision (first aid) for the prevention of serious complications from minor accidents. Under medical service systems the employees and their dependents, in consideration for a fixed periodic deduction from wages, are furnished medical and hospital care through medical personnel employed by or under contract to the employer.

¹ Bureau of Medical Economics Jour Am Med Assn April 4 1936 106, 1182-1183

² The second in a series of articles on group hospitalization

rotates monthly in alphabetical order Meetings second Tuesday of each month at University Center

TENNESSEE STATE RADIOLOGICAL SOCIETY
President, H S Shoulders, M D, 246 Doctors Bldg, Nashville, *Vice-president* S S Marchbanks, M D, 508 Medical Arts Bldg, Chattanooga, *Secretary-treasurer*, Franklin B Bogart, M D, 311 Medical Arts Bldg, Chattanooga Meeting annually with State Medical Society in April

VERMONT

See New England Roentgen Ray Society

VIRGINIA

RADIOLOGICAL SOCIETY OF VIRGINIA *President*, Fred M Hodges, M D, 100 W Franklin St, Richmond, *Vice-president*, L F Magruder, M D, Raleigh and College Aves, Norfolk, *Secretary*, V W Archer, University of Virginia Hospital, Charlottesville

WASHINGTON

WASHINGTON STATE RADIOLOGICAL SOCIETY
President, H E Nichols, M D, Stimson Bldg, Seattle, *Secretary*, T T Dawson, M D, Fourth and Pike Bldg, Seattle Meetings fourth Monday of each month at College Club

CALIFORNIA

THE SECTION ON RADIOLOGY OF THE CALIFORNIA MEDICAL ASSOCIATION met May 2-5, at Hotel Del Monte, Monterey County, and elected for the 1937-38 *Chairman*, this past year's *Secretary*, John D Lawson, M D, 1306 California State Life Bldg, Sacramento, and *Secretary*, Karl M Bonoff, M D, 1930 Wilshire Blvd, Los Angeles

INDIANA

THE INDIANA ROENTGEN SOCIETY held its annual meeting at Indianapolis on May 9, with J C Bell, M D, of Louisville, Ky, as guest for the day After dinner he addressed the Society on 'The Less Common Diseases of the Colon, including Amebiasis' Officers chosen for the coming year are *President*, J N Collins, M D, Indianapolis, *President elect*, Stanley Clark, M D, South Bend, *Vice-president*, Juan Rodriguez, M D, Fort Wayne, and *Secretary-treasurer*, Clifford C Taylor, M D, Indianapolis

MINNESOTA

The annual meeting of the MINNESOTA RADIOLOGICAL SOCIETY was held in St Paul,

Minnesota, in connection with the meeting of the Minnesota State Medical Society The annual Carman Lecture was delivered to the general assembly of the Minnesota State Medical Association by Edward H Skinner, M D, of Kansas City, on "Reflections on the Roentgenology of Fractures"

Dr Skinner also addressed the Minnesota Radiological Society on the subject "Comments upon Early Books upon Electricity and the Roentgen Ray"

Robert S Stone, M D, of San Francisco, delivered the annual Christian Lecture on Cancer before the State Medical Society His subject was "Irradiation Therapy of Tumors, with a Consideration of the Possibilities of Super-voltage X-rays" He also addressed the Minnesota Radiological Society on "The Professional and Economic Status of the Radiologist."

Officers for the coming year were elected as follows *President*, Walter H Ude, M D, Minneapolis, *Vice-president*, Leo G Rigler, M D, Minneapolis, *Secretary-treasurer*, Harry Weber, M D, Rochester

MISSOURI

THE ST LOUIS SOCIETY OF RADIOLOGISTS has recently been re-organized, with the following officers elected for the forthcoming year *President*, Joseph C Peden, M D, and *Secretary*, W K Mueller, M D Meetings are now held the fourth Wednesday of each month

NORTH CAROLINA

THE NORTH CAROLINA RADIOLOGICAL SOCIETY met May 3-5, in Winston Salem, electing the following officers *President*, Robert P Noble, M D, Raleigh, *Vice-president*, A L Daughtridge, M D, Rocky Mount, and *Secretary-treasurer*, M I Fleming, M D, Rocky Mount

Part of the meeting was taken up with a rather lengthy discussion and an unanimous vote of the Society that the members discourage the employment by hospitals of a radiologist who is not especially qualified, the hospital paying a nominal salary and charging the regular x-ray fee for his services This means that some of the hospitals in the State are using an interne or a young doctor who is not especially qualified in x-ray as their x-ray man and charging the patients a fee for his service not in keeping with the salary he gets The Society wishes to go on record that such a procedure is not in keeping with its idea of a real radiologist

'Group medical practice plans or so-called private group clinics, whereby physicians cooperate in their practice, share office space, own certain kinds of equipment and employ lay assistants in common, are frequently cited as examples of desirable group payment arrangements. A comprehensive study of such groups,⁶ however, revealed that less than 9 per cent (20 out of 224) had ever tried any arrangement for service in return for regular periodic payments. Furthermore, despite the claimed economies of group medical practice plans, it was found that the cost of practising medicine in private practice varies from 27 to 34 per cent of gross income, with an average tendency of 33 per cent, whereas in group medical practice the cost varies from 40 to 42 per cent, or from 7 to 9 per cent more than in private practice.

"A few communities organized 'health associations' to provide hospitalization and medical or nursing services to subscribing members. While such organizations have usually been subsidized by foundations, welfare federations, or other community institutions, the essential distinction is that the administration is separate from the physicians and hospitals providing the service. Such arrangements did not lend themselves to the average American community because of their dependence on community or special benevolent funds and the restricted character of their activities.⁷

"In universities and colleges, student health services were organized to meet the requirements of supervising and protecting the health of students on the campus through entrance examinations, consultations and infirmary care, instruction in personal and public hygiene, and the control of communicable diseases. Such organizations might be compared to industrial health services with particular emphasis on health education. The tendency to extend student health services into comprehensive medical care plans is similar to that which exists

under industrial health services. Again, the claimed economies of group arrangements do not seem to materialize because, in spite of uncertain accounting methods, the reported cost per student is not appreciably less than the cost for similar services in the private purchase of medical and hospital care.⁸

"It should be noted that all of the several plans which have been outlined have provisions for periodic payments by members to establish a fund for hospital, and sometimes medical, bills. Nevertheless, such plans are not group hospitalization plans. The characteristics which set group hospitalization plans apart from these plans will be outlined later.

"The Beginnings of Hospital Plans—With the background of industrially dominated group payment for medical and hospital care, it is not surprising that hospitals should form plans to accumulate funds through individual contributions and then through group payroll deductions.

"In the latter part of the nineteenth century hospitals began selling 'season tickets,' entitling the purchaser to hospital benefits in case of accident or illness, as a means of securing advance working capital. The practice started, presumably in the small hospitals of Michigan for workers in the lumber woods, although some hospitals in cities, such as the Broadstreet Hospital in New York City, were supported by annual pledges of employees and employers.

"The first organized payment plan for hospital services offered to the general public by a hospital was that of the Grinnell Community Hospital, Grinnell, Iowa, which began operation in 1918. Subscription rates were \$8 a year for single persons and \$12 for husband and wife, with \$5 for the first child and \$2.50 for each additional child. Later, students of Grinnell College were admitted for \$5 per college year. The benefits included three weeks of hospital care consisting of board and room and floor nursing service, but did not include use of operating room, delivery room, x-ray, or laboratory fees, or the costs of dressings or special nursing. This plan is still in operation and has remained practically unchanged in rates, contract provisions, or size of membership.

⁶ Group Practice Bureau of Medical Economics, American Medical Association. Chicago, American Medical Association 1933. p. 29. Compare with Rorem C. R. Private Group Clinics. Committee on the Costs of Medical Care. Publication 8, Chicago, University of Chicago Press 1931.

⁷ Williams chapter X. Peables and McDermott. Nursing Service and Insurance for Medical Care in Brattleboro Vermont. Committee on the Costs of Medical Care. Publication 17. Chicago, University of Chicago Press 1932. Falk, Griswold, and Spicer. A Community Medical Service Organized under Industrial Auspices in Roanoke Rapids. North Carolina. Committee on the Costs of Medical Care, Publication 20. Chicago. University of Chicago Press 1932.

⁸ University and College Student Health Services. Bureau of Medical Economics, American Medical Association. Chicago. American Medical Association, 1936. Compared with Griswold and Spicer. University Student Health Services, Committee on the Cost of Medical Care, Publication 19, Chicago, University of Chicago Press 1932.

Industrial health services are extended to provide care for acute and chronic illnesses and more or less complete medical care for the employee's family

"The creation of medical service systems to furnish complete medical, surgical, and hospital care for employees does not seem to be the proper function of industry. Financial provisions may be made by industry to alleviate the lack of individual employee income, but the medical and hospital service should be given by physicians and hospitals independent of industry. Under such an arrangement the employer could help employees to purchase medical and hospital services without undesirable entanglements in the medical field. It is believed that personnel managers would welcome an arrangement for medical services which does not place their companies between the patient and his physician or hospital

"There is need for much further consideration of the discrimination against independent physicians and hospitals and of the inequities placed on the employee by industrial medical systems.³ At present it is sufficient to note that, in certain industries, employees and their dependents receive medical and hospital care (part of which is definitely the legal liability of the employer), under a group payment plan, from physicians employed in company-owned hospitals or from physicians and hospitals under contract with the employer

"It was not long before medical and hospital benefit organizations were formed in imitation of the associations contracting for the care of patients entitled to compensation. Under the various plans, funds were accumulated from individual subscribers as well as from groups of employees through the sale of contracts. Complete medical and hospital services were offered through hospitals and clinics owned by the organizers or through physicians and hospitals under contract with the corporation. In the States where the laws or the courts denied corporations the right to practise medicine,

these organizations made little progress, but in those States in which the laws did not restrict such corporations they were promoted at a pace that would astound even a firm believer in the gullibility of the American people. In one State alone 143 such organizations were formed, 37 of which used two or more names. Many of these corporations (some of which appeared to be only on paper) defrauded thousands of people of money which they thought they were paying for future medical services until grand jury action was secured and the laws were altered to prohibit such swindling corporations. In other localities similar organizations were more honestly promoted, but, while avoiding criminal fraudulence, they still retained the contract features restricting free choice and preventing freedom of reasonable competition on a service basis.⁴

"Many mutual benefit associations or sick benefit funds organized by employees, trade unions and fraternal societies developed alongside the industrial health services and medical systems. The primary function of these plans was to collect payments from the group into a fund to provide benefits in cash for members requiring assistance. These organizations, after the losses from industrial injuries were transferred to the employer, confined themselves to ordinary sicknesses or injuries not the result of employment. In addition to cash benefits for loss of time, several of the plans included payments for medical and hospital care. Only a few plans provided such service 'in kind' through salaried physicians and association-owned hospitals or through physicians and hospitals under contract with the association. Most of the plans also included medical and hospital service for dependents of members. By far the greater number of these plans were little more than charity arrangements in that they were designed primarily to aid the member who became impoverished because of illness or accident.⁵

³ For a full discussion of the evolution of industrial medical services see (a) Medical Relations under Workmen's Compensation—Revised Bureau of Medical Economics American Medical Association Chicago American Medical Association 1935 (b) Williams Pierce The Purchase of Medical Care through Fixed Periodic Payment New York, National Bureau of Economic Research, Inc., 1932 (c) Dodd W F Administration of Workmen's Compensation New York Commonwealth Fund 1936 (d) Medical Supervision and Service in Industry New York National Industrial Conference Board, Inc 1931

⁴ These organizations are discussed in New Forms of Medical Practice Bureau of Medical Economics American Medical Association Chicago American Medical Association 1933 pp 61-64 Leland R G Contract Practice Jour Am Med Assn March 5 1932 98, 808 Some Phases of Contract Practice Am Med Assn Bull October 1932 27, 142 New Plans of Medical Service Chicago, Julius Rosenwald Fund 1936

⁵ Medical benefits under mutual and sick benefit associations are discussed by Brundage D K A Survey of Work of Employees' Mutual Benefit Associations Pub Health Rep Sept. 4 1931 46, 2102 Williams chapter XII

FREE SUMMER COURSE ON BOARD TRAINING SHIP FOR BOYS AND YOUNG MEN¹

In order to acquaint the youth of America with the opportunities of a career as officers in the United States Merchant Marine, the American Nautical Academy, National Training School for Merchant Marine Officers, Washington, D C, has announced that boys and young men between the ages of 10 and 26 years will be allowed to secure practical ship experience on board a training ship of the Academy within the period from June 1 to October 1

The young men may remain on board ship for the entire period or for any shorter time they may wish, but not for less than three weeks

There is no tuition charge for any of the courses offered by the Academy, and no obligation for future merchant marine, military, or naval service of any kind is incurred by the young men

There is no charge for instruction nor for living quarters on board ship The only required expense is for meals which are 49 cents Three meals are served daily

The schoolship to which the young men will be assigned is the Training Ship *Marsala*, a five-masted barkentine-rigged vessel of 2,500 tons, 300 feet long, and 46 feet wide The vessel was built in 1919-20 and is one of the largest sailing vessels in the world

While on board ship cadets will receive free medical treatment when necessary On Sundays the young men will be allowed to attend divine services at the churches of their respective denominations ashore

This is the eighth annual summer course offered by the Academy, and will be under the personal supervision of the Captain Commandant of the Academy who will be in command of the vessel

While on board ship the boys will follow the regular daily ship routine, and will be given practical instruction in nautical subjects including seamanship (ship's work), signaling, rowing, handling, and the use of motor and life boats, life-saving, and naval drills They will also receive instruction in the use of life buoys, first aid, the duties of lookouts, the compass, log, lead, and ground tackle, as well as the duties of the watch in port and at sea

Students will join the training ship in the

vicinity of New York Harbor for the summer training period

Those completing the summer course with a passing grade will be eligible to apply for a scholarship in the Regular Course

The Regular Course covers a period of three years The first two of these years the cadet spends cruising, and studying on the training ship For the third year the cadet is assigned to a steamship of one of the merchant marine lines Following the completion of these three years of sea service the cadet is eligible to take the officer's examination of the United States Bureau of Navigation and Inspection, Department of Commerce, for a certificate as a Third Officer in the Deck Division of steamships in the Merchant Service of the United States

Due to the fact that the number of accommodations available is limited, those wishing to take advantage of this opportunity should write at once to the American Nautical Academy, National Training School for Merchant Marine Officers, Washington, D C

BOOK REVIEW

THE LUNG By WILLIAM SNOW MILLER, M D, Emeritus Professor of Anatomy, University of Wisconsin A volume of 209 pages with 152 illustrations Published by Charles C Thomas, Springfield, Illinois, 1937 Price, \$7 50

This short monograph presents a most important contribution to the literature dealing with the anatomy of the lung There is probably no one better qualified to deal with the subject, and able to present in the same excellent and readable style, than the author It should be carefully studied by all physicians, and especially those interested in diseases involving the lung

The book is divided into twelve chapters, each dealing with some important structural element of the lung The chapters are abundantly illustrated, the illustrations adding materially to a better understanding of the anatomical detail The diagram representing the structural scheme of a primary lobule is especially worthy of notice While each chapter pays attention to anatomical detail, the material is presented in such a fashion that it blends readily into a compact whole

¹ This summer course seems to offer physicians an attractive summer occupation for their young sons

"Many other plans for facilitating the purchase of hospital care were organized, such as the Hospital Service Association of Rockford, Ill., in 1912, the Thompson Benefit Association for Hospital Service, Brattleboro, Vt., in 1927, and the New Bedford Health Association, New Bedford, Mass., in 1929. These undertakings were community ventures to carry the risk of illness on a group basis but with the provision of hospital and medical service left largely to independent local agencies.

"Alongside the organized undertakings, individual hospitals formed a multitude of other plans designed to bolster the diminishing income from patients, gifts, and endowments and at the same time to make hospitalization costs less for patients of moderate means."

COMMUNICATIONS

INTERNATIONAL CONGRESS OF SHORT WAVE SPECIALISTS

Vienna, Austria, July 12-17, 1937

The scientific workers in one of the most rapidly advancing fields of physics, chemistry, biology, and medicine will convene in congress in Vienna under the patronage of Dr. D'Arsonval, Dr. Zenneck, Senator Marconi, and of official Austria as represented by a committee including the Federal President, the Austrian Chancellor, the Rector of the celebrated University of Vienna, the Rector of the Vienna Technical College, and the Mayor of the City of Vienna. The Congress sessions will comprise lectures by world-famous scientists, followed by brief papers by members, and by general discussions. The papers read by members must not take more than fifteen minutes reading time. Those wishing to read papers are requested to file a special application. The languages admitted are English, German, French, and Italian. The major papers read, as well as those presented by members, will be printed in full and copies distributed to those attending the Congress provided applications are received in time. In conjunction with the Congress an exhibit showing the latest advances in the short wave field, both in the abstract field and the field of applied practice, will remain open throughout the Congress.

The subjects to be dealt with include physics, biology, chemistry, and medicine. In

the field of physics the subjects to be covered are the properties of short waves and ultra-short waves, generation, conduction, radiation, and propagation, reflection, refraction, absorption, measurement of SW and USW, exploration of Heaviside-Appleton layers of the atmosphere, chemistry and physical chemistry will be thoroughly explored in their relation to short wave work and the practical aspects of short wave application in the physical field will be treated extensively.

In biology the action of short waves of various types on plants, animals, organisms, enzymes, and ferments, heat effect and size particles, percutaneous SW diathermy, destruction of noxious insects. Experiments will be included.

In the medical field, the connection of which with short wave therapy has aroused world wide interest, the following topics will receive attention: indications and counter-indications for the therapeutical application of SW and USW, USW therapy—its application in cases of acute inflammations of bacterial genesis in internal medicine, surgery, gynecology, dermatology, ophthalmology, otiatry, and neurology, SW therapy in connection with acute infectious diseases, especially with polymyelitis acuta, sensibilization by SW of malign neoplasms refractory to x-rays, SW diathermy—its application in cases of chronic rheumatic diseases of joints and muscles, the technical side of apparatus.

All lectures and discussions will take place in the morning, leaving the afternoons free for demonstrations, experimental work, or sight-seeing tours. Membership fee of the Congress is thirty Austrian schillings which fee includes the cost of all printed reports. The fee is payable in the local currency to the official Austrian representatives abroad. A crowded calendar of social events including official receptions and merry excursions has been planned to supplement the serious work of the members of the Congress.

Programs and application blanks will be furnished upon request to the Congress of Short Wave Specialists, 630 Fifth Ave., New York City.

Announcements concerning the Fifth International Congress of Radiology and the joint meetings of the radiological societies (Chicago Sept. 13-17, 1937) will appear in future issues.

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ABSTRACTS OF CURRENT LITERATURE

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THE FOLLOWING ABSTRACTORS HAVE CONTRIBUTED TO THIS ISSUE

J N ANÉ, M D , of New Orleans, La	W A SODEMAN, M D of New Orleans La
E T LEDDY M D , of Rochester, Minn.	WILLIAM R STECHER, M.D , of Easton Pa
ERNST A POHLE M D , Ph D , of Madison, Wis	CHARLES G SUTHERLAND, M.B , of Rochester, Minn

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SKELETON

A Radiologic Study of Some Anomalies and Congenital Malformations of the Skeleton and the Joints Mariano Cipriani *Archivio di Radiologia*, March-April, 1936, 71-90

The author discusses the roentgenologic aspects of some anomalies and malformations of the bones and joints among which are a case of "foramen supratrochleare humeri," "os intermedium antibrachii," "ectromelia," "syndactylism," "hyperdactylism," and "os trigonum tali." Of special interest was the case of a girl nine years of age who had hyperdactylism of all the digits and syndactylism of the hands, bilateral coxa valga, hypoplasia and dysplasia of the tibias, and hyperplasia and dysplasia of the fibulas. The author draws up a classification of such lesions and, in conclusion, emphasizes the importance that skeletal anomalies and malformations may have in medico legal questions.

E T LEDDY, M D

TUMORS (THERAPY)

Treatment of Tumors of the Reticulo-endothelial System Ira I Kaplan *Jour Med Soc New Jersey*, December, 1936, 33, 696-701

For the purpose of radiation therapy certain tumors may be classified in distinct categories entirely upon the basis of the nature of their response to this radiant energy. Tumors of the reticulo-endothelial system, which have not as yet been pathologically or embryologically linked to a single tissue of embryonal origin, may be classified purely through clinical radiation therapy. The point of origin cannot dictate the reason for the radiosensitivity but leads to a grouping of tumors accordingly. Leukemia, lymphosarcoma, Hodgkin's disease, lympho-epithelioma, and the endothelioma of bone are placed in one group as representative of very sensitive tumors. The less rapidly regressing xanthochromatoses such as Gaucher's, Schüller-Christian's and Niemann-Pick's disease, are placed in a second group.

W A SODEMAN, M D

Giant-cell Bone Tumor Further Observations on Treatment Carleton B Peirce and Isadore Lampe *Jour Am Med Assn* Dec 5 1936 107, 1867-1871

A series of 40 cases are reviewed with particular reference to the results obtained in treatment. With thorough curettage surgery alone is effective in the control of this tumorous lesion of bone. Adequate curettage with or without cauterization was as effective as curettage with radiation. In cases in which the location of the tumor, the age or physical condition of the patient, or the loss of time incident on surgical attack were factors radiation offered symptomatic relief and anatomic improvement. Radiation alone

offered as much for the control or cure of giant-cell tumor as either of the other methods. Large or massive doses are theoretically of less value than smaller and more frequent amounts of radiation and tend to be more irritating to the normal connective tissue elements.

CHARLES G SUTHERLAND, M B (Tor)

Electrolysis or Diathermic Coagulation in the Treatment of Vascular Tumors of the Face Roberto Pochy-Riano *Archivio di Radiologia*, March-April, 1936, 121-133

The author reports the checking by surgical diathermy of a case of extrinsic cavernous hemangioma of the upper lid of an 18 months-old baby.

E T LEDDY, M D

The Influence of Sugar and Insulin Injection upon the effect of X rays on Malignant Tumors K Inouye *Strahlentherapie*, 1937, 58, 125

The author studied the relation between sugar injection and metabolism of sarcoma in rabbits in connection with roentgen irradiation of the tumor. The sarcoma was transplanted on the back of rabbits and received from 1 200 to 6 000 r. Tumor growth, body weight and duration of life of the animals were used as criteria. Intravenous injection of 20 c c of a 20 per cent glucose solution increased the metabolism of the sarcoma. The inhibiting effect of roentgen rays on the metabolism of the tumor was increased if preceded by sugar injection. Insulin injection (1 c c per kilogram of body weight) after the exposure to roentgen rays has the same effect. Sugar injection before roentgen irradiation seems to inhibit the growth of the tumor and increase the duration of the life of the animals. If sugar is injected and not followed by irradiation, the general condition of the animals is improved, but the tumor grows more rapidly and is fatal in a shorter time. While roentgen irradiation alone is followed by decrease of the tumor size, it causes enough systemic injury to shorten the duration of the life of the rabbits. The growth of implanted tumors may be inhibited by early roentgen irradiation.

ERNST A POHLER, M D, Ph D

On the Spacing of Radiation According to Variation in Radiosensitivity J C Mottram *British Jour Radiol*, December, 1936, 9, 824-832

The author exposed bean roots to radium radiation at varying intervals in relation to the mitotic activity. His results showed that 6-hour spacings were less effective in causing death of the bean root, or in temporarily stopping growth, than the 24-hour spacings. It was also demonstrated that unspaced exposures of the same total time are less damaging than the 24-hour spacings, though slightly less than the 6-hour spacings. In the experiments employing 24 hour spacings the cells were irradiated at both exposures when mitosis was abundant. In the 6-hour spacings the second exposure was administered when mitosis was in abeyance.

It is believed that if the radiosensitivity of tumors could be measured during life, radiation could be more efficiently applied to patients. It would then be possible to expose the tumor during periods of high sensitivity and avoid those periods of great resistance. While this is possible in the case of experiments the only means to estimate radiosensitivity of tumors is by frequent measurements of the tumors, and assuming that during regression the tumor will be resistant and during growth, sensitive.

J N ANÉ M D

ULTRA-VIOLET LIGHT

Experimental Studies on the Influence of Ultra violet Rays on Cell Protoplasm L N Klyatschkin Strahlentherapie, 1937, 58, 330

The author exposed mice to the quartz mercury vapor lamp without filter and also through the so-called Wood filter. The kidneys, liver, and spleen were studied histologically then by means of a modified Altmann stain. Definite structural changes could be demonstrated which made their appearance at the time. No changes whatsoever in the nucleus could be detected by the customary histologic method. The author observed those changes as early as one hour after exposure.

ERNST A POHLE M D, Ph D

THE UTERUS

The Question of Colposcopy E Anderes Schweiz med Wchnschr Nov 14 1936, 46, 1107-1111

The entire future of therapeutic results in carcinoma of the cervix depends upon means of establishing an early diagnosis. Since the devisement of the colposcope by Hinselmann rapid strides have been made, namely in the detection of incipient carcinoma of the portio such as is readily overlooked in ordinary direct examination. If one does not utilize a colposcope the author recommends the routine employment of the Schiller iodine test and advises that in all negative cases, an auxiliary colposcopic examination by an experienced examiner should be conducted.

WILLIAM R STECHER, M D

Blood Changes in Patients with Carcinoma of the Uterus before and after Radiation Therapy and Their Prognostic Significance H Goecke Strahlen therapie 1936 57, 675

The blood counts of 110 patients with carcinoma of the uterus (100 carcinoma of cervix and 10 fundus) were studied before radiation and four months later. This corresponded to a period of two months after the last treatment. It appeared that the changes occurring in the blood count after radiation therapy can be used as a guide in prognosis. If hemoglobin and erythrocytes increase after the treatment while the leukocytes decrease and the shift to the left returns toward

normal, at the same time the lymphocytes remaining high, the prognosis is usually favorable. A further drop in hemoglobin and erythrocytes after radiation therapy is unfavorable. The same conclusions may be drawn from the appearance of a leukocytosis with marked shift to the left and drop of lymphocytes and eosinophils.

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ERNST A POHLE M D Ph D

THE WRIST

Treatment of Luxation of the Lunate Peter Steiner Schweiz med Wchnschr May 23 1936, 66, 504-507

The author presents an excellent review of luxation of the lunate, intercarpal luxation and other carpal bone injuries. The importance of this study cannot be over emphasized when one considers that more than half of all carpal bone injuries and particularly luxation of the lunate are diagnosed only after three weeks' duration, which factor makes all manual non-operative reduction impossible. The only method of diagnosing this condition and even then only in skilled hands is by roentgenology. An early diagnosis is the key note to therapy. For before three weeks elapse excellent results in reduction are obtained by employing the Böhler technic which essentially consists of continuous traction with the hand in supination. When luxation is older than three weeks operative reduction is necessary which is as successful as the non-operative method. However in old luxations operative removal is necessary if there is pain and interference with articular motion. In the latter regard conservative treatment may be advisable if the terminal results appear certain of non-success. Associated avulsion of the styloid process of the ulna is common as is transverse fracture of the navicular. The luxation can best be noted in the lateral projection and a control roentgenogram of the opposite wrist is always indicated. Excellent illustrations showing the lesions are given and radiologic hints for diagnosis are well worth while reading in the original. The mechanism of luxation is clearly shown and the dictum that every so-called sprained wrist due to the patient having fallen on the dorsally flexed hand is a luxation of the lunate until disproven, is very valuable.

WILLIAM R STECHER, M D

RADIOLOGY

A MONTHLY JOURNAL DEVOTED TO CLINICAL RADIOLOGY AND ALLIED SCIENCES

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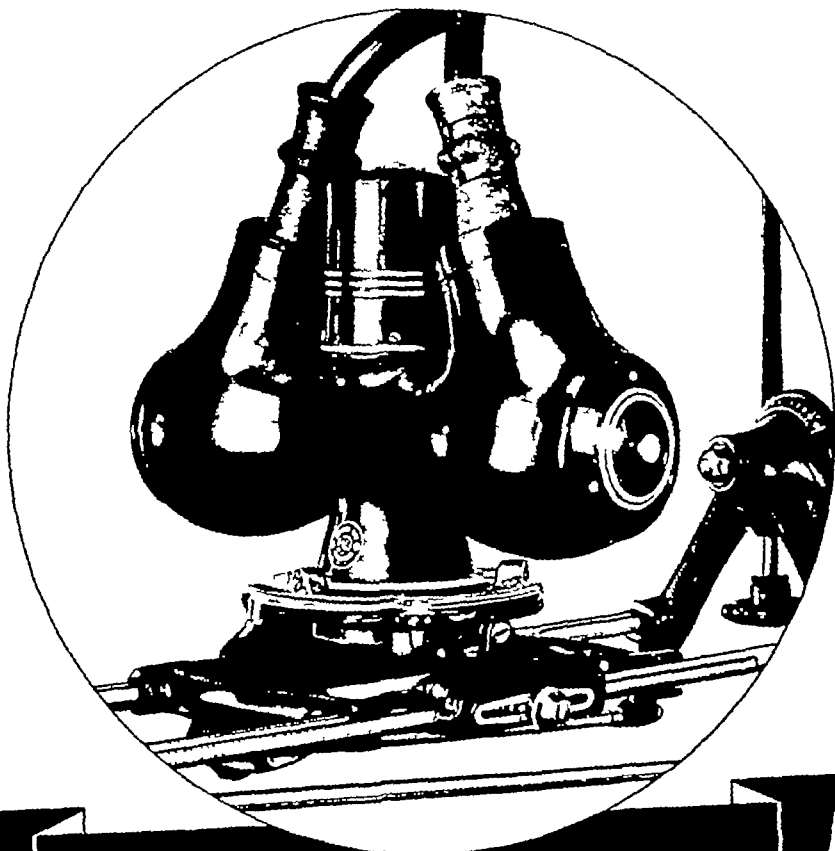
WILLIAM R STECHER M D

RADIOLOGY

A MONTHLY JOURNAL DEVOTED TO CLINICAL RADIOLOGY AND ALLIED SCIENCES

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- Idem. Treatment of selected cases of chronic catarrhal deafness by x rays, Jan 1.
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- SIEBERT ALFRED C. (of Osteopetrosis) R. M. Smith and A. T. Smith May 12
- STONE ROBERT S. (of Non-carcinomatous tumors of stomach) R. A. Carter and D. R. Laing March 12
- TROSTLER I. S. (of Use of pentobarbital sodium for roentgen nausea and vomiting) W. C. Popp and M. W. Binger Feb 12
- WILLMOTH A. DAVID (of Symposium on female pelvis) April 12
- WILSON RABUN T. (of Neoplasms involving duodenum) S. Weintraub and A. Tucker March 12

